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ABSTRACT

This curriculum guide includes teaching packets for 21 problem areas to be included in a core curriculum for 10th grade students enrolled in a rural agricultural program. Covered in the four units included in this volume are crop science (harvesting farm crops and growing small grains); soil science and conservation of natural resources (understnading soils, judging land-use capability, buying and using fertilizers); horticulture (identifying trees, shrubs, and flowers; propagating plants sexually and asexually; and growing and caring for indoor plants); and agricultural mechanics (developing arc and acetylene welding skills, surveying in agriculture, and developing basic shop skills). Each problem-area packet includes some or all of the following components: suggestions to the teacher, teacher's guide, information sheet, student worksheets or assignment sheets and key, demonstrations, job sheets, transparencies, discussion guide for transparencies, and sample test questions and teacher's key. (MN)

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ED220690

CORE II MATERIALS FOR RURAL AGRICULTURE PROGRAMS

Units E-H

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June, 1982

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Product Abstract

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____ 03 Business and Office Education
____ 04 Distributive Education
____ 07 Health Occupations Education
____ 09 Home Economics Education
____ 10 Industrial Art Education
____ 16 Technical Education
____ 17 Trade and Industrial Education
____ Career Education
____ Other (Specify) ____

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8. Education Level:

____ Pre-K Thru 6
____ 7-8
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____ 11-12
____ Post-Secondary
____ Adult
____ Teacher (Pre-service)
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____ Other (Specify) ____

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X Classroom Teacher
____ Local Administrator
____ Teacher Educator
____ Guidance Staff
____ State Personnel
____ Other (Specify) ____

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16. General Description (State the general objective and suggested method in use. Summarize the content and tell how it is organized. Continue on back of this sheet or on another sheet, if necessary.)

This curriculum guide includes teaching packets for 21 problem areas selected as suggested areas of study to be included in a core curriculum for tenth-grade or seond-year students enrolled in a rural agriculture program.

17. Person Completing this Abstract: Paul E. Hemp

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1310 S. Sixth St.
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1C 8213304

UNIT E: Crop Science

PROBLEM AREAS:

1. Growing small grains
2. Harvesting farm crops

UNIT E: CROP SCIENCE

PROBLEM AREA: GROWING SMALL GRAINS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade or second-year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is in the fall during the wheat planting season. The estimated time for teaching this problem area is 2 to 4 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. Students have received basic instruction on tillage operations.
2. Students will have the opportunity to visit area fields to observe and/or participate in planting small grains.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts this problem area to his/her local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-32-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect or should they be construed as policy or opinion of the State Board of Education or its staff.

The teacher's guide and worksheets were developed by Chris Mowrer and Jerry Pepple, Department of Vocational and Technical Education, University of Illinois.

Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Crop science

II. Problem area: Growing small grains

III. Objectives: At the end of the problem area, the student should be able to:

1. Select the proper type and variety of small grains.
2. Prepare a seedbed for small grains.
3. Estimate fertility needs for small grains.
4. Use proper planting and cultural practices (time and depth of seeding, etc.).
5. Control weeds, pests and diseases in small grains.

IV. Suggested interest approaches:

1. Have a class discussion on the role of wheat in the world, national, state and local agriculture.
2. Have students name as many varieties of wheat as they can.
3. Have students name uses of small grains.
4. Ask students why small grains should be grown on their farms. (feed crop, cash crop, cover crop, nurse crop)
5. Identify students with small grain S.O.E.P.'s and have them lead a class discussion on their project. Plan a field trip to their farms.

V. Anticipated problems and concerns:

1. What kinds and varieties of small grains are grown in our area?
2. What factors should be considered in selecting a variety?
3. How do small grains fit into a crop rotation?
4. When should small grains be planted?
5. How should the seedbed be prepared?
6. What method of seeding should be used?
7. How do I control weeds in small grains?

8. What should the seeding rate be?

9. How much fertilizer should be applied?

10. How do I control insects?

11. How do I control diseases?

VI. Suggested learning activities and experiences:

1. Have students identify their problems and concerns and record them on a chalkboard.

2. Have students read reference material, and discuss tentative answers to problems and concerns. (See Part IX for list of references and aids)

3. Have students plan possible crop rotations that include small grains.

4. Discuss double-cropping, identify the advantages and disadvantages.

5. Distribute Worksheet #1 and/or #2 and reference material. Have students complete worksheets.

6. Display the wall chart "Crop Varieties for Illinois." (Sent out annually in the Ag Releases). Identify varieties used in the community and characteristics of common varieties.

7. Take a field trip to a farm where small grains are being planted. Observe tillage methods, seeding rate and depth, operation and adjustment of the grain drill, etc.

8. Obtain some wheat or oat seeds and conduct a germination test. Discuss importance of good germination and how germination affects planting rates.

9. Show VAS Slidefilm or Slideset #773 "Diseases of Wheat." Discuss the diseases common to the community and identify approved methods of control.

VII. Application procedures:

1. The main purpose of this problem area is to introduce students to the benefits of using small grains in a crop rotation and conservation program.

2. The students should be able to plan and conduct a small grain S.O.E.P.

VIII. Evaluation of student progress:

1. Evaluate and grade worksheets.

2. Administer test.

3. Evaluate students oral reports and class discussion.

IX. References and aids:

A. Subject matter units from Vocational Agriculture Service:

1.	VAS 40236	Growing Oats
2.	VAS 4027b	Growing Wheat
3.	VAS 4056	Wheat Diseases

B. VAS Slidefilm (or slide set) 773 - Diseases of Wheat - Cassette & Study Guide Available.

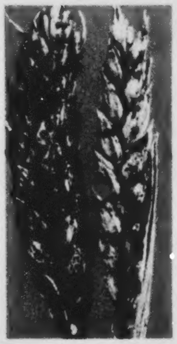
C. Miscellaneous VAS Materials:

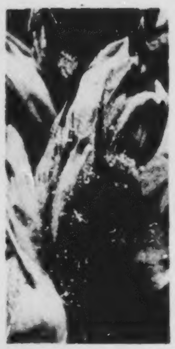
1. Approved practices for wheat
2. Approved practices for oats
3. Plant disease picture sheets
    (a) Wheat diseases I
    (b) Wheat diseases II
    (c) Oat diseases
    (d) Barley and Rye diseases

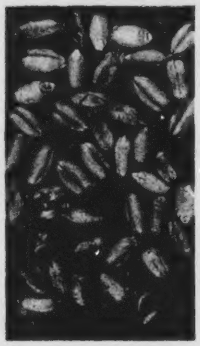
D. Crop Varieties for Illinois - Wallchart, sent out annually in Ag. Releases

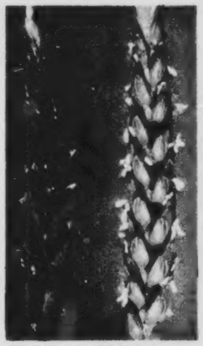
E. The Agronomy Handbook, Cooperative Extension Service, University of Illinois.

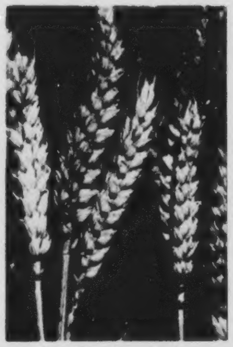
WHEAT DISEASES I

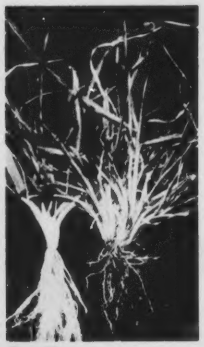

1. Black head molds

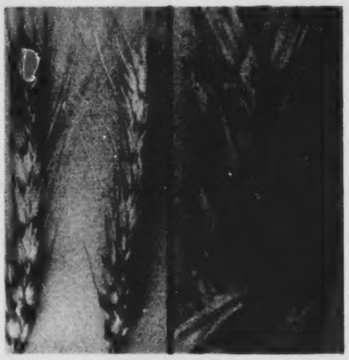

2. Botrytis head mold

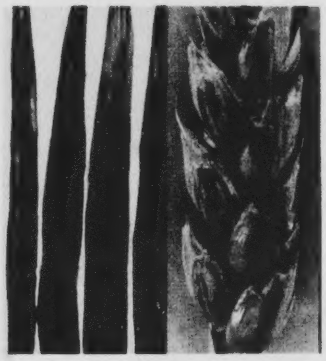

3. Common bunt or stinking smut

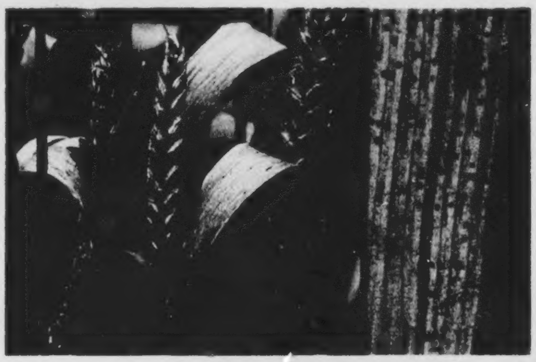

4. Loose smut. R, healthy head

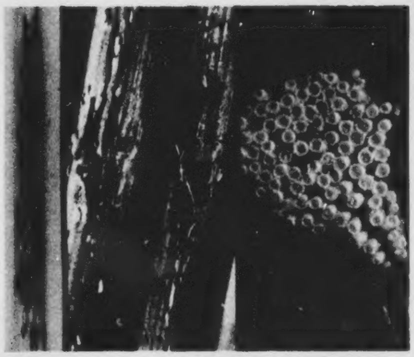

5. White heads *(Fusarium)*

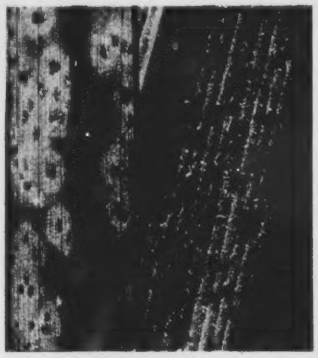

6. Foot rot *(Fusarium culmorum)*

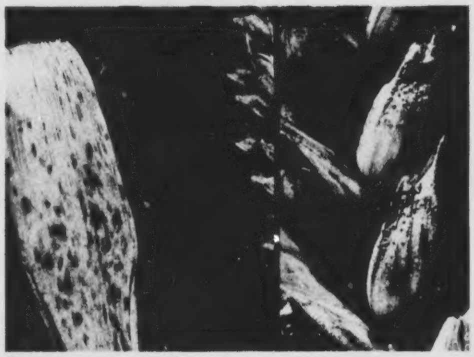

7. Scab or head blight

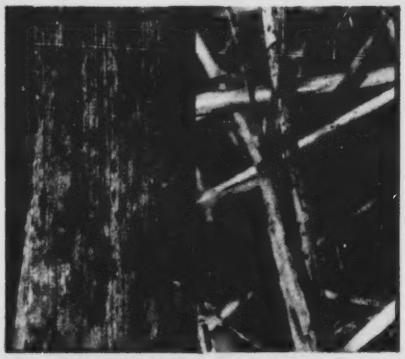

8. Black chaff. L, leaf and R, glume symptoms

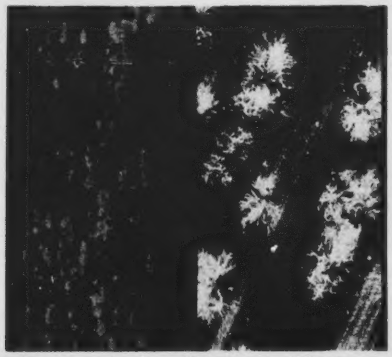

9. Septoria leaf blotch. R, pycnidia of *Septoria tritici* in leaf lesion

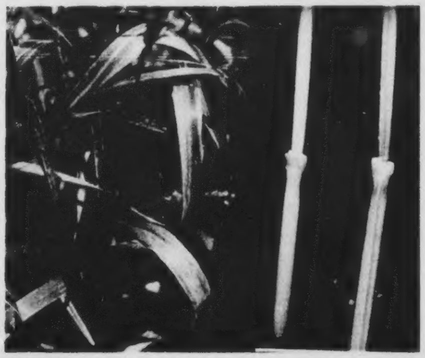

10. Stem rust. L, telial stage; C, uredial stage; R, aecial stage on barberry leaf


11. Leaf rust


12. Septoria leaf and glume blotch *(S. nodorum)*. L, leaf and R, glume symptoms


13. Tan or yellow leaf spot. R, pseudothecia of *Pyrenophora trichostoma* on straw


14. Powdery mildew. L, black specks (cleistothecia) in older colonies


15. Cephalosporium stripe. L, leaf and R, culm symptoms (left culm is healthy)

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

PLANT DISEASE NO. 5
JANUARY 1980
URBANA, ILLINOIS

WHEAT DISEASES I

1. **Black Head Molds** are species of *Cladosporium* and *Alternaria* and to a lesser extent *Stemphylium*, *Epicoccum*, and *Sporobolomyses*. These fungi, often called "sooty molds," give an olive-brown to black appearance to the glumes and grain. These molds infect during damp weather at or near grain maturity, and are most severe when harvest is delayed. Plants predisposed to other diseases, shading, nutrient deficiency, and lodging are most susceptible. The fungi survive mosty in plant refuse.

2. **Botrytis Head Mold**, caused by the fungus *Botrytis cinerea*, is a minor, late season disease. Warm, wet weather at or near harvest increases the incidence of this disease. Infected glumes and kernels are blue-gray to black due to growth of the fungus. Plants weakened by disease or other disorders are most susceptible. The fungus has a wide host range and survives on plant debris.

3. **Common Bunt or Stinking Smut** is caused by two closely related fungi, *Tilletia caries* and *T. foetida*. The fungi produce plump "smut balls" that replace the kernels and cause the glumes to spread apart. These balls have a fishy odor and crush at harvest to release a cloud of dark spores (teliospores or chlamydospores). Infected plants are slightly stunted and the heads usually remain green longer than those on healthy plants. Cool soil temperatures favor seedling infection. The fungus overseasons as teliospores on seed and in soil.

4. **Loose Smut** is caused by the fungus *Ustilago tritici*. Unlike Common Bunt (3), Loose Smut does not affect seed quality. The smutted heads, with the kernels replaced by black masses of spores, are clearly visible shortly after they emerge. At harvest, only a naked rachis remains of a smutted head. Wheat plants are only susceptible to infection for about a week at flowering time. The fungus invades the embryo of the developing seed, remains dormant until the kernel germinates, and then colonizes the terminal growing point.

5. **White Heads**—the blasting and killing of inflorescences— is a symptom common to many disorders including Fusarium Foot Rot (6), Cephalosporium Stripe (15), Eyespot, Rhizoctonia Sharp Eyespot, Take-all, copper deficiency and insects such as the stem maggot (*Meromyza americana*) and stem sawflies (*Cephus* spp.). Species of *Fusarium* and other fungi are splashed into the upper leaf sheaths during rainy weather and colonize nodal areas. Under moisture stress, infected stem tissue inhibits the upward flow of water resulting in death of the head.

6. **Foot Rot**, caused by the soil-borne fungus *Fusarium culmorum*, is economically important in many areas of the USA, especially in warmer soils. Plants under moisture or nutritional stress or insect injury are very susceptible. Light-brown to reddish-brown lesions develop on subcrown internodes, coleoptiles and primary roots. Above ground plant parts can become infected from stubble-produced spores which incite irregular tan blotches on the leaves or White Heads (5). The greatest yield loss comes from stands thinned by foot and crown infections which are often lethal to seedlings. The fungus overseasons on plant refuse, seed and in soil.

7. **Scab or Head Blight** is caused by species of *Fusarium*, primarily *F. roseum* f. sp. *cerealis* (perfect stage, *Gibberella zeae*). One or more spikelets per head turn prematurely straw-colored when glumes on healthy spikelets are still green. Infected spikelets are usually sterile or contain bleached to grayish-brown, shriveled and rough kernels. A pink to orange mold often grows at the base of diseased spikelets. Black perithecia of *G. zeae* develop **on** old wheat heads. Scab is most serious when warm moist weather occurs from flowering time to near maturity. Diseased grain contains mycotoxins that are poisonous when fed to swine, horses, dogs, and humans. The fungi overseasons on and in seed and soil plus cereal, grass and corn residues.

8. **Black Chaff**, caused by the bacterium *Xanthomonas translucens* f. sp. *undulosa*, appears as dark brown to black or olive-green, interveinal blotches and streaks on the glumes, awns, leaves, sheaths, necks, and stems. Slime or tiny droplets appear on the lesions in wet weather and dry into minute yellow scales. Diseased heads mature late, may be sterile if infected before flowering, or produce kernels that are shrunken at their bases. The bacterium overseasons in seed, living and dead plants, and soil.

9. **Septoria Leaf Blotch** is caused by the fungus *Septoria tritici*. Small, light green-to-yellow spots on the leaves and sheaths enlarge and merge to form irregular, tan-to-reddish-brown blotches with grayish-brown to ash-colored centers often partly surrounded by a yellow margin. Black specks (pycnidia) form in older lesions or at stem nodes. Affected leaves often turn yellow, wither and die early. The fungus survives in living and dead wheat plants and in seed.

10. **Stem Rust**, caused by the long-cycled rust fungus *Puccinia graminis* f. sp. *tritici*, occurs on stems, leaves, sheaths, and heads. When severe, grain may be shriveled and light weight. The oblong, reddish-brown uredial pustules are tattered with fragments of wheat epidermis. The pustules release masses of dusty urediospores that reinfect wheat. As the wheat matures, the pustules gradually turn black when telia and teliospores develop. To complete its life cycle an alternate host, common barberry (*Berberis vulgaris*, *B. canadensis*, *B. fendleri*) or species of *Mahonia*, is required. The teliospores germinate in early spring to produce basidiospores which infect nearby alternate hosts and form orange-to-yellow leaf spots called pycnia. Later, on the opposite side of the same leaf, aecial "cluster cups" develop containing golden aeciospores. These spores infect nearby wheat plants completing the disease cycle. The fungus overwinters on wheat stubble and in the uredial stage on living plants in the southern USA and Mexico. The wind-borne urediospores spread northward as the season progresses.

11. **Leaf Rust**, caused by the fungus *Puccinia recondita* f. sp. *tritici*, appears as small, round-to-oval, orange-yellow dusty pustules (uredia) on the leaves and sheaths, sometimes the stems, and occasionally the glumes and awns. On a resistant wheat only small yellow flecks or spots without uredia develop. As wheat matures, glossy, dark gray-to-black covered telia are produced. The alternate host, species of meadow rue (*Thalictrum*), is infected in Europe but this is rare in the USA. The rust fungus overwinters in the uredial stage on living wheat plants in the southern USA and Mexico. The wind-borne urediospores spread northward as the season progresses.

12. **Septoria Leaf and Glume Blotch** is caused by *Septoria nodorum* (perfect stage, *Leptosphaeria nodorum*), closely related to the Septoria Leaf Blotch fungus (9). *S. nodorum* infects the leaves, sheaths and stems producing symptoms very similar to *S. tritici*. Enlarging, grayish or brownish blotches, which later turn chocolate-brown, form on the glumes. The centers turn grayish-white and are studded with black pycnidia. The fungus overwinters in living and dead plants and in seed.

13. **Tan or Yellow Leaf Spot**, caused by the fungus *Pyrenophora trichostoma* (imperfect stage, *Helminthosporium tritici-repentis*), can be serious where no-till is practiced. Diseased leaves often turn yellow, wither and die early. Small, yellow-to-tan-brown flecks enlarge to lens-shaped brown lesions, up to 12 mm long, with a yellow border. In the fall, raised black pseudothecia form on wheat stubble. These structures mature in winter and spring to produce ascospores that infect the next wheat crop.

14. **Powdery Mildew** is caused by the fungus *Erysiphe graminis* f. sp. *tritici*. White-to-light gray, powdery patches form on the leaves, sheaths, stems and floral bracts. Black, speck-sized cleistothecia form in the mildew growth as the crop matures. Where severe, infected leaves wither and die early. The fungus overseasons on living and dead plants.

15. **Cephalosporium Stripe**, caused by the fungus *Cephalosporium gramineum* (imperfect stage, *Hymenula cerealis*) is associated with wet soils and more or less continuous cultivation of winter wheat. Yellow then brown stripes develop on the stems and often continue the length of the leaf. One to four stripes form per leaf. Older leaves gradually turn yellow and die. Diseased plants are stunted and produce white, poorly filled heads with shriveled kernels. The fungus overseasons in crop debris and soil near the surface.

For chemical control suggestions, a listing of resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: BASF (1, 2, 5, 9, 10C, 11, 14R), University of Wisconsin (3), R. W. Samson (4), The American Phytopathological Society (6, 14L), T. M. Sjulin (7, 10L), University of Nebraska (8L, 13), M. G. Boosalis (8R), J. A. Browning (10R), and unknown (15L).

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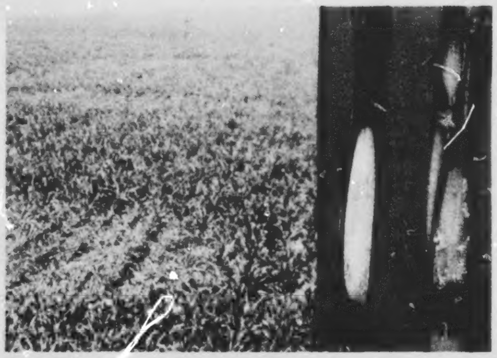
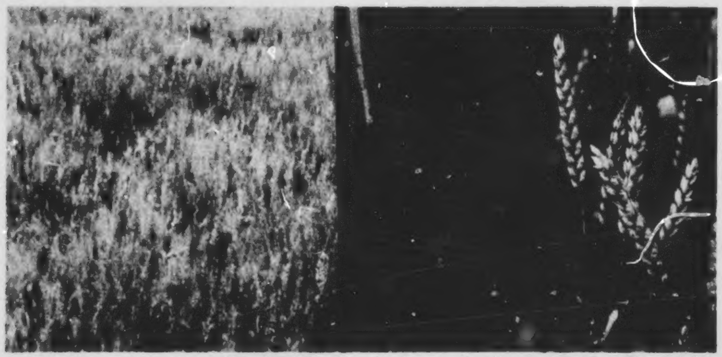
WHEAT DISEASES II

1. Foot rot or eyespot. L, lodging in a field; C, and R, lesions on culms



2. Rhizoctonia bare patch, L; sharp eyespot lesions on clums, R



3. Take-all. L, in the field; C, darkened clum bases; R, white heads

4. Helminthosporium root and crown (foot) rot. L, field; R, decayed crowns

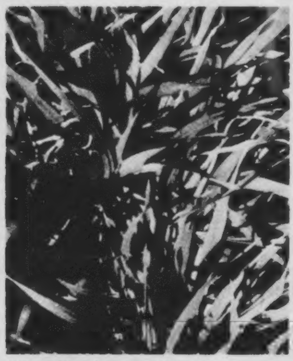
5. Frost injury

6. Winter injury

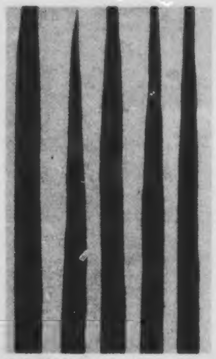
7. Fusarium root and crown (foot) rot

8. Typhula blight or speckled snow mold. L, infected plants; R, sclerotia

9. Soil-borne mosaic. L, in a low-lying field; R, leaf symptoms



10. Barley yellow dwarf



11. Wheat streak mosaic

12. Herbicide (Trifluralin) injury

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PLANT DISEASE NO. 6
JANUARY 1980
URBANA, ILLINOIS

WHEAT DISEASES II

1. **Foot Rot or Eyespot**, also known as strawbreaker, is caused by the soil-borne fungus *Pseudocercosporella (Cercosporella) herpotrichoides*. Maturing plants lean or break over (lodge) in all directions from a basal stem or foot rot that develops during wet weather in autumn, winter and early spring. Lens-shaped, white-to-light tan lesions with dark brown margins and up to 4 cm long, form vertically on the stems and lower leaf sheaths near the soil line. Diseased plants are often yellowish and mature early with white, sterile heads or with poorly filled kernels. The fungus overseasons in cereal and grass debris.

2. **Rhizoctonia Bare Patch or Sharp Eyespot** is caused by the cosmopolitan soil-borne fungus *Rhizoctonia solani*. Unlike Foot Rot or Eyespot (1), both roots and stems of winter and spring wheats are infected with a brownish decay. Bare or thin patches of stunted seedlings and older plants, having a purplish cast to the lower stems and leaves, are scattered throughout a field, and are characteristic of root attack. Sharply defined, lens-shaped, light tan to straw-colored spots with deep brown margins form vertically on the leaf sheaths up to ten inches or more above the soil line. These eye-shaped lesions closely resemble those of Eyespot (1). When roots are infected, plants may lodge and produce white heads. The fungus survives as small, brown-black sclerotia in soil and as mycelium in the debris of many kinds of plants.

3. **Take-All**, caused by the fungus *Gaeumannomyces (Ophiobolus) graminis* var. *tritici*, is most serious in sandy, alkaline, infertile soils where cereals, especially wheat, and grasses are grown intensively. Winter wheat is more seriously damaged than is spring wheat. Affected plants are stunted to severely dwarfed (uneven in height) in localized areas. Such plants have a reduced number of tillers, somewhat yellowed leaves, ripen early, may lodge in all directions, and develop white heads that are sterile or poorly filled and later darkened by "sooty molds." Roots, crowns and stem bases develop a brittle, dry, brown-to-black rot. A superficial, coal-black mycelial mat forms **under** the lower leaf sheaths. The fungus overseasons in soil as well as cereal and grass debris.

4. **Helminthosporium Root and Crown (Foot) Rot**, also called dry land foot rot, is caused by the fungus *Helminthosporium sativum* or *H. sorokinianum* (perfect stage, *Cochliobolus sativus*). A reddish-brown to dark brown decay develops in the coleoptiles and subcrown internodes and later in the crowns and roots. Seedlings may be killed before or after emergence. Plants that survive are stunted, lack vigor, produce few tillers, mature early, and form heads that are bronzed to a bleached-white. Such heads have shriveled seed. The disease occurs in random patches and is most severe in plants under stress from drought, high temperatures, nutrient deficiencies, or insect injury. The same fungus incites another disease known as spot blotch. Oval to elongated, dark brown spots with a definite margin form on the leaves. The spots may merge to form large blothes that girdle and kill the leaves. The fungus survives in crop and grass debris, soil, and on or in seed.

5. **Frost Injury** often occurs to winter wheat plants in low-lying areas in the spring. Affected leaves may have a bronzed appearance or the leaf tips are bleached. Heads that emerge are often variously distorted, bleached, at least partially sterile, and susceptible to attack by various "sooty molds." Early spring frosts can kill plants to the soil line. Frost injury often predisposes surviving plants to root and crown rotting fungi.

6. **Winter Injury** is more serious to winter wheat than is frost damage since much larger areas are usually affected. Plants may be heaved out of the soil from repeated freezing and thawing. Heaved plants, with sheared-off roots, are vulnerable to disiccation by sun and wind. Unless new roots are regenerated in the spring, such plants turn yellow, wither and die. Small patches to large areas of weak or dead plants are evident in early spring.

7. **Fusarium Root and Crown (Foot) Rot**, caused primarily by the fungus *Fusarium graminearum* (synonym *R. roseum* f. sp. *cerealis* 'Graminearum'), which incites Scab or Head Blight, invades injured root and stem (crown) tissues in cool wet weather, but damage is most evident in warm-to-hot weather when plants are under stress. Other species of *Fusarium* common in wheat roots include *F. avenaceum* and *F. culmorum*. Seedlings may wither and die while older plants mature early producing fewer tillers and white heads with mostly shriveled seed. Dry, light-brown to reddish-brown lesions develop in invaded coleoptile, crown (foot) and root tissue. The greatest yield loss occurs when infection of the crown or foot reduces the stand in random or irregular patches. Surviving diseased plants are brittle, stunted, and a lighter green than normal plants. The fungi overseasons on plant refuse, seed and in soil.

8. **Typhula Blight or Speckled Snow Mold** is caused by two closely related fungi, *Typhula incarnata* and *T. idahoensis*. Disease symptoms appear when the snow melts in northern winter wheat growing regions. Under snow cover, a dense, white-to-gray mold (mycelium) grows over moist plant parts. Numerous small brown sclerotia amongst the mycelia growth gives the characteristic speckled appearance. Dead withered leaves are common but diseased plants usually recover in warm dry weather unless the crown is seriously infected. In this case plants may be killed over extensive areas. The *Typhula* fungi overseason as sclerotia in soil or as mycelium in plant residue.

9. **Soil-Borne Mosaic** is a virus disease transmitted from diseased to healthy plants by a soil-borne fungus, *Polymyxa graminis*. Winter wheat plants growing in poorly drained, low-lying areas of fields appear light green to bronzy-yellow or light purple, patchy, or uneven during prolonged, cool spring weather. The disease is sometimes mistaken for Winter Injury (6). Leaves and leaf sheaths are irregularly mottled and striped light and dark green to lemon-yellow. The stunted to dwarfed and yellowish plants tend to recover and appear normal when the weather turns warm. Kernels in affected heads are often shriveled and light weight. The virus and its fungus vector overseason in soil and crop residues.

10. **Barley Yellow Dwarf** is a prevalent virus disease of wheat and other cereals. Disease outbreaks coincide with flights of aphids that transmit the virus when they feed on a diseased plant and then a healthy one. Plants may be stunted to dwarfed and yellowish. Leaves are stiffer and more erect than normal. Early-infected plants are flattened and may winter-kill due to poor root development. Tillering is reduced, maturity is slowed, and spikelets may be blasted. Kernels in affected heads are often shriveled and light weight. In tolerant wheats the symptoms can be nondescript and easily confused with nutrient deficiencies, winter injury, root rot, or other virus disease. The yellow dwarf virus overseasons in living grass and cereal plants and is transmitted by about a dozen species of aphids, which are blown northward as the season progresses.

11. **Wheat Streak Mosaic** is a virus disease transmitted up to 1½ miles by the wheat curl mite (*Aceria tulipae*) and from plant-to-plant by leaf contact. The disease is worst in early-seeded, autumn-infected fields. Light green to faint yellow blotches, dashes and streaks, parallel to the veins, develop in wheat leaves during mid to late spring. Infected plants become stunted with golden-yellow, mottled and streaked leaves. Plants tend to spread more than normal and to tiller excessively. Early-infected plants fail to head or may produce only a few shriveled kernels. When severe, plants may die before maturity. The virus overeseasons in living cereal, grass and corn plants.

12. **Herbicide (Trifluralin) Injury** is most common in turning areas at the edge of a field that receive an excessive amount of chemical. In other cases, misapplication is the problem. Where wheat is grown in rotation with a legume crop, carryover of the herbicde may injure wheat seedlings. The leaves on such plants may have reddish margins. The roots appear pruned and "stubby."

For chemical control suggestions, resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: BASF (1, 2R, 3R, 7, 8), The American Phytopathological Society (2LO), University of Illinois (3L, 9, 11), T. M. Sjulin (3C), University of Nebraska (4), E. W. Palm (5, 6), S. G. Jensen (10), and A. H. Estein (12).

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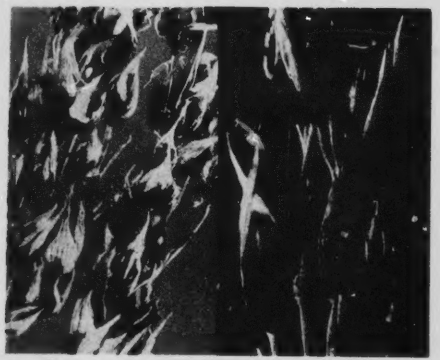
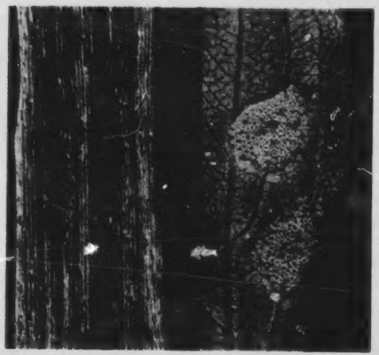
OAT DISEASES

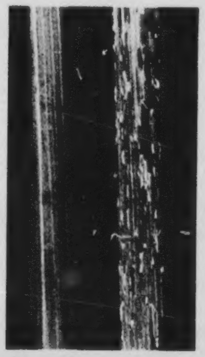
1. Septoria blight. L, leaf blotch with close up of lesion with pycnidia; C, culm lesions; R, kernel blight



2. Smut

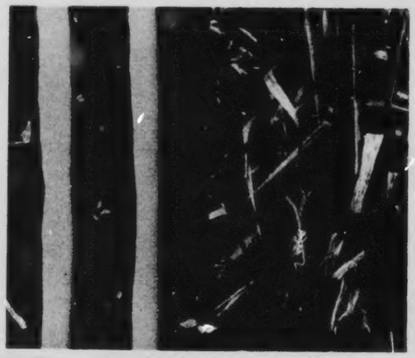


3. Crown rust. L, uredial stage; R, aecial stage on *Rhamnus* leaf



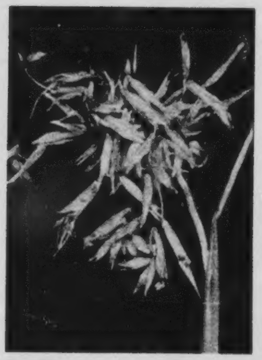
4. Stem rust on culms

5. Stem rust on leaf



6. Bacterial stripe and halo blights. L, leaf and R, plant symptoms

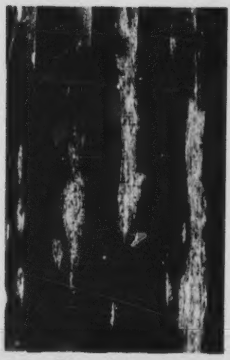
7. Helminthosporium leaf blotch



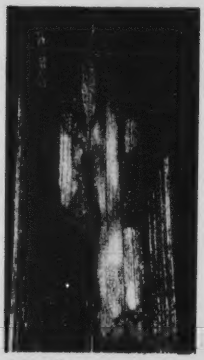
8. Downy mildew or crazy top

9. Anthracnose on culms

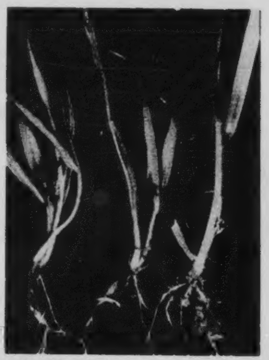
10. Yellow dwarf



11. Physiologic leaf spot



12. Gray speck



13. Pythium seedling blight

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

PLANT DISEASE NO. 9
JANUARY 1980
URBANA, ILLINOIS

OAT DISEASES

1. **Septoria Blight** or disease (also called Septoria black stem, leaf blotch, speckled blotch, and speckled leaf blotch) is caused by the fungus *Septoria avenae* f. sp. *avenae* (perfect stage, *Leptosphaeria avenaria*). Round to elongate or diamond-shaped, yellow to light or dark brown blotches, with a dull brown margin, form first on the lower leaves then spread upward. Speck-sized black pycnidia later form in the centers of older blotches as infected leaf tissue dies. Grayish-brown to shiny black lesions develop mostly on the upper parts of stems beneath infected leaf sheaths. Diseased plants commonly lodge near maturity. Yellow to dark brown lesions occur on the outer glumes. Dark brown or black lesions may extend to the lemma and palea and eventually the groat of the kernel. The *Septoria* fungus overwinters in crop debris.

2. **Smut.** Two smuts commonly infect oats: covered smut, caused by fungus *Ustilago kolleri*; and loose smut, caused by the closely related fungus *Ustilago avenae*. Dark brown to black, powdery masses of smut spores replace the grain and often the awns and glumes. The spores of covered smut are contained within a whitish-gray membrane which is somewhat more presistent than that of loose smut. All spikelets and panicles become infected; smutted panicles do not spread as much as healthy ones. Infected plants are shorter than healthy ones and are easily overlooked at harvest since the mass of spores is quickly scattered by wind and rain leaving a denuded panicle which is hard to see. Both smut fungi are seed-borne and constitute the only source of inoculum. Plants are susceptible to infection only in the seedling stage.

3. **Crown Rust**, caused by the fungus *Puccinia coronata*, is a long-cycled rust that has species of buckthorn (*Rhamnus*) as an alternate host. Uredial pustules are round-to-oblong and appear bright orange-yellow on oat leaves, sheaths, stems and panicles. The uredia burst open to release orange masses of urediospores which infect other oat plants. If severe, infected stems may lodge. As the oat plant matures, grayish-black telia form in a ring around old uredia or may develop independently. The telia remain covered indefinitely by the epidermis. In the spring, teliospores germinate to form basidiospores that infect nearby buckthorn leaves to form bright orange-to-yellow pycnia. Opposite the pycnial spots, usually on the lower leaf surface, aecia later appear as raised, orange cluster cups that produce golden-yellow aeciospores that infect neaby oat plants, completing the disease cycle. The fungus overwinters as teliospores in oat debris in the north and in the uredial stage on oats in the southern USA and Mexico. The urediospores are blown northward as the season progresses.

4 & 5. Stem Rust, caused by the fungus *Puccinia graminis* f. sp. *avenae*, is a long-cycled rust (like Crown Rust 3 above) that has the common barberry (*Berberis vulgaris*) as the alternate host. Uredia and telia occur on oat stems, leaves, sheaths, and panicles. Uredial pustules are large, oblong, dark reddish-brown, and soon release masses of rust-colored urediospores that infect other oat plants. The black, usually oblong telia form in and around the uredia, especially on the stems and sheaths of maturing plants. The dark teliospores are exposed by rupturing of the epidermis. In the spring, teliospores germinate to form basidospores that infect nearby common barberry leaves. Pycnia appear as bright orange-to-yellow spots in early spring. Later, on the opposite side of the leaf, the aecia develop as raised, orange cluster cups. These cups produce golden-yellow aeciospores that infect nearby oat plants, completing the disease cycle. The fungus overwinters as teliospores in oat debris in the north and in the uredial stage on oats in the southern USA and Mexico. The urediospores are blown northward as the season progresses.

6. **Bacterial Stripe and Halo Blights** commonly occur together on oat leaves following cool, wet and windy weather. Bacterial stripe, caused by the bacterium *Pseudomonas striafaciens*, first appears as sunken, water-soaked dots which later enlarge into water-soaked blotches or stripes, that become a translucent rusty-brown. Halo blight, caused by *Pseudomonas coronafaciens*, first appears as small, pale, green, oval-to-oblong, water-soaked spots on the leaves, that later turn yellow to light brown. Severely infected leaves turn brown and die back. The bacteria causing both diseases overwinter on seed and in crop debris.

7. **Helminthosporium Leaf Blotch** is caused by the fungus *Helminthosporium avenae* (perfect stage, *Pyrenophora avenae*). Oblong-to-elongate, light reddish-brown spots develop on seedling leaves. On older leaves the lesions start as small brown flecks that develop into elongated blotches or stripes. The outer edges of the lesions are yellow or reddish. Sometimes infected leaves are withered without forming well-defined lesions. Infected kernels turn brown at the basal end. The fungus is seed-borne and also overwinters on oat residue.

8. **Downy Mildew** usually occurs only in wet areas of a field. It is caused by the fungus *Sclerospora (Sclerophthora) macrospora*. Infected plants are stiff, upright, stunted to dwarfed, and tiller excessively. The upper leaves may be curled about the panicles which are often curled, twisted and deformed into a cluster of tangled spikelets (crazy top) that resembles 2,4-D injury and produces no viable seed. The fungus is seed-borne and can survive from year to year as oospores in host residue and in soil.

9. **Anthracnose**, caused by the fungus *Colletotrichum graminicola*, produces reddish-brown, lens-shaped lesions on the leaves. Infected crowns and stems become bleached then brown. Diseased tissue becomes covered with minute dark acervuli which appear as "pin cushions" under magnification. Panicles on diseased plants produce lightweight shriveled grain. The fungus overwinters as mycelium or spores on crop residue.

10. **Yellow Dwarf** or red leaf is caused by the barley yellow dwarf virus. Yellowish-green spots and blotches form in the leaves. The lesions soon enlarge, merge, and turn various shades of yellow-red, orange, red, or reddish-brown. Eventually, entire leaves turn dull orange or red; usually from the tip backward and from the margins inward. Early-infected plants may be severely dwarfed and die early or produce heads with numerous blasted spikelets. The virus overseasons in perennial grasses and is transmitted by a dozen species of aphids after feeding on diseased plants.

11. **Physiologic Leaf Spot**, in some cases at least, is associated with an inability of oat leaves to recover from water-soaking due to high humidity. The condition is accentuated by rapid drying along with an abrupt change from a cool-moist to a warm-dry environment. The symptoms vary on different oat varieties. Typically, the leaf spots are round to elongate or irregular in shape and from ash-gray to a straw color. Distinct concentric areas of different shades of color may be present. Most commercially-grown oat varieties have good resistance to this disorder.

12. **Gray Speck** is caused by a deficiency of available manganese in the soil. It is a problem in alkaline-organic and other low-manganese soils that have a high pH. Light-green to gray-brown spots and streaks form in the leaves. If severe, yields are reduced and the entire plant may become yellow and stunted. Control is by application of manganese salts to the soil or by spraying the plants with a weak solution of manganese sulfate. Certain oat varieties are much more tolerant of manganses deficiency than are others.

13. **Pythium Seedling Blight** is caused by several species of the *Pythium* fungus. Seeds or seedlings are often killed before emergence. Seedlings that do emerge are stunted and yellowed with water-soaked translucent areas in the roots that later turn a reddish-brown. Some infected plants recover but usually are never as vigorous as healthy plants. The causal fungi overseasons in infected crop residue or soil.

For chemical and cultural control suggestions, a list of resistant varieties and other control measures, consult the Extension Plant Pathologist at your land-grant university or your county extension office.

Photo credits: BASF (1L, 2L, 3L, 7), N. A. Smith (1C), A. L. Hooker (1R), J. A. Browning (2R, 3R, 4, 5, 11, 12), University of Illinois (6, 8), University of Wisconsin (9), E. W. Palm (10L), American Phytopathological Society (10R), and British Ministry of Agriculture, Fisheries and Food (13).

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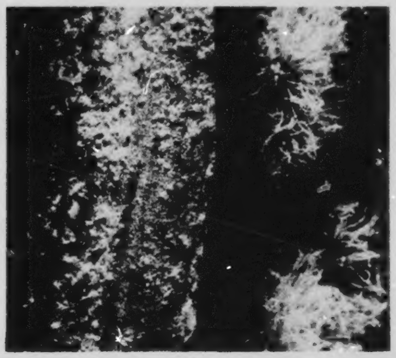
BARLEY AND RYE DISEASES

1. Kernel blight or black point on barley

2. Spot blotch on barley

3. Net blotch on barley

4. Helminthosporium stripe on barley


5. Powdery mildew on barley

6. Leaf rust on barley

7. Barley stem rust

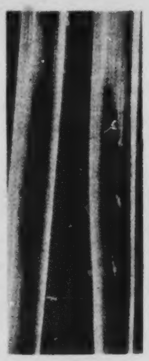
8. Barley scald

9. Septoria leaf blotch of barley

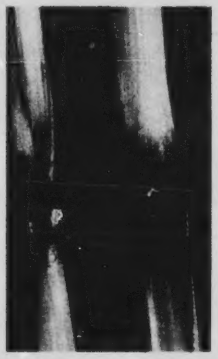
10. Barley yellow dwarf. L, field symptoms; C, plant symptoms; R, aphids

11. Loose and covered smuts of barley

12. Bacterial stripe blight


13. Rhizoconia culm canker

14. Typhula blight of barley


15. Fusarium culm canker

16. Ergot on rye. L, honeydew stage

17. Take-all on rye

UNIVERSITY OF ILLINOIS COLLEGE OF AGRICULTURE
COOPERATIVE EXTENSION SERVICE
and VOCATIONAL AGRICULTURE SERVICE

PLANT DISEASE NO. 10
JANUARY 1980
URBANA, ILLINOIS

BARLEY AND RYE DISEASES

1. **Kernel Blight or Black Point**, commonly caused by the fungus *Helminthosporium sativum* (synonyms *Bipolaris sorokiniana*, *Drechslera sorokiniana*, *H. sorolinianum*; perfect stage, *Cochliobolus sativus*), appears as small black spots to a dark discoloration of barley glumes and kernels. Affected grains may be shriveled and lightweight. When planted, these kernels fail to germinate or produce dwarfed seedlings that later wither and die. Dark brown sunken lesions form near the seed, in young stems, and in crowns and roots, up to heading. The same fungus causes Spot Blotch (2).

2. **Spot Blotch** appears as enlarging, round-to-oblong, chocolate-brown to black spots on the sheaths over seedling leaves. The lesions may merge to form irregular blotches causing leaves of all ages to wither and die early. The fungus (*Helminthosporium sativum*) overseasons in crop residue, soil, seed, and seedling leaves of winter barley.

3. **Net Blotch**, caused by the fungus *Helminthosporium teres* (perfect stage, *Pyrenophora teres*), occurs as oblong to narrow, chocolate-brown blotches on the leaves and develop a cross-hatched "netting." The lesions enlarge and merge to form long brown stripes with irregular margins. The leaves do **not** split, as with Helminthosporium Stripe (4). The fungus overseasons in and on seed and barley residue.

4. **Helminthosporium Stripe** or stripe disease, caused by the fungus *Helminthosporium gramineum*, appears as narrow, pale green-to-yellow streaks that extend the length of barley leaves. The streaks turn tan with reddish or dark brown margins and affected leaves shred lengthwise. Diseased plants are severely stunted, produce few tillers, and usually do not head. The fungus overseasons on and in infected seed and dead leaves.

5. **Powdery Mildew**, caused by the fungus *Erysiphe graminis* f. sp. *hordei*, forms a white-to-light gray, powdery growth on leaves, sheaths, stems, glumes, and awns. Mildewed leaves may turn yellow then wither and die early. If severe, plants may lodge or produce fewer poorly filled heads. Black, speck-sized structures (cleistothecia) form in the mycelial growth on maturing plants. Where winters are mild the fungus overseasons on living plants and in northern areas as cleistothecia on plant residue.

6. **Leaf Rust**, caused by the fungus *Puccinia hordei*, is seen as small, round-to-oval, yellow-orange dusty pustules mostly on leaves and sheaths. Heavily infected leaves die prematurely. The uredial pustules may merge and turn into slate-gray telia usually covered by the epidermis but are nonfunctional in the USA. The fungus overseasons in **living** plants in the south. The urediospores are wind-borne northward as the season progresses.

7. **Barley Stem Rust**, caused by the rust fungi *Puccinia graminis* f. sp. *secalis* and *P. g.* f. sp. *tritici*, occurs on stems, leaves, sheaths, and heads. When severe, grain may be shriveled and lightweight. The elongate, reddish-brown, uredial pustules are **tattered** with fragments of barley epidermis. The pustules release masses of dusty urediospores that reinfect barley. The uredia turn into black telial pustules containing teliospores as the crop matures. To complete its life cycle an alternate host, common barberry (*Berberis vulgaris*, *B. canadensis*, *B. fendleri*) or species of Mahonia, is required. The teliospores germinate in early spring to produce basidiospores which infect nearby alternate hosts and form orange-to-yellow leaf spots called pycnia. Later, on the other side of the leaf, aecial "cluster cups" develop containing aeciospores. These spores infect nearby barley plants to complete the disease cycle. The fungus overwinters on barley stubble and in the uredial stage on living plants in the southern USA and Mexico. The urediospores blow northward as the season progresses.

8. **Barley Scald** is caused by the fungus *Rhynchosporium secalis*. Large, oval to lens-shaped lesions with a gray-tan center and dark brown or purple-brown margin develop on leaves and sheaths. Lesions may merge to form irregular blotches that kill the leaves. Older lesions may be zonate. The fungus overseasons in seed, living leaves, and crop debris.

9. **Septoria Leaf Blotch** is caused by the fungus *Setoria passerinii*. Elongated, yellowish to light brown leaf spots often merge to form irregular blotches with "pinched" margins. Dark brown pycnidia form in older, straw-colored spots. The fungus overseasons on and in barley debris and volunteer plants.

10. **Barley Yellow Dwarf** is caused by virus that causes barley plants to be stunted to dwarfed (very uneven in growth) and turning golden-yellow starting at the tips of older leaves. Diseased plants tiller excessively and form few heads that are poorly filled. Early infected plants are most seriously affected. The BYD virus overseasons in **living** winter cereals, perennial grasses and about a dozen species of aphids that transmit the virus to healthy plants.

11. **Loose and Covered Smuts** are caused by two fungi: Loose smut by *Ustilago nuda* and covered smut by *U. hordei*. Barley grains are replaced by masses of smut spores covered by a whitish-gray membrane. The dark-brown loose smut spores are released when the head emerges from the boot leaving only a naked spike (rachis) at harvest. The membrane covering purplish-black masses of covered smut spores ruptures at or near grain maturity. The loose smut fungus overseasons as dormant mycelium **inside** normal-appearing seed. The covered smut fungus mostly survives as spores on seed.

12. **Bacterial Stripe Blight**, caused by the bacterium *Xanthomonas translucens*, appears as water-soaked dots on the leaves and sheaths that enlarge into irregular, narrow, light yellow to dark brown streaks. Small droplets on the lesions dry into a flaky, glossy film. The bacterium overseasons in seed, plant refuse, living plants, and soil.

13. **Rhizoctonia Culm Canker** (sharp eyespot and Rhizoctonia root rot), caused by the fungus **Rhizoctonia solani**, may infect barley at any growth stage. Lens-shaped lesions with tan centers and dark brown margins form on the lower leaf sheaths. Small, dark brown-to-black sclerotia may form on lesions and between the culm and leaf sheath. Seedlings may die but surviving plants often produce new roots. When severe, a brown root and crown rot, causes plants to lodge and produce white heads. The fungus survives in soil and debris of many plants.

14. **Typhula Blight** is caused by the fungi *Typhula incarnata* and *T. idahoensis*. In northern barley-growing areas, a white-to-gray mycelial mat grows over moist plant parts and soil under the snow cover. Many small brown sclerotia in the mycelial growth gives a characteristic speckled look to the withered leaves. Plants usually recover unless the crown is seriously infected; then plants may die over extensive areas. The *Typula* fungi overseason in soil and on living or dead plants.

15. **Fusarium Culm Canker**, caused mostly by the fungus *Fusarium roseum* f. sp. *cerealis*, may produce Kernel Blight or Black Point (1), Scab, Root Rot, and Seedling Blight. Often occurring in patches, diseased plants are stunted, pale green, mature early, and produce few tillers with withered lower leaves. Brownish girdling cankers may form at the crown, base of lower leaf sheaths, and at the stem nodes. Seedlings often turn yellow and die. Roots may develop a reddish-brown decay. Scab appears as a bleached, premature ripening of all or part of a head. Kernels may be shrunken, grayish-brown and lightweight. The fungi overseason in soil, seed, and crop residue.

16. **Ergot**, caused primarily by the fungus *Claviceps purpurea*, attacks cereals and grasses. The fungus infects open flowers producing a yellowish, sugary liquid (honeydew) filled with spores. Insects attracted to the honeydew, feed on it, and carry the spores to healthy flowers where new infections occur. Near maturity, each infected kernel turns into a large hornlike, purplish-black ergot body or sclerotium on or in the soil or with grain.

17. **Take-all**, caused by the fungus *Caeumannomyces (Ophiobolus) graminis* var. *tritici*, occurs wherever rye and other cereals are grown intensively. In localized areas the plants are very uneven in height, form few tillers, and ripen prematurely with bleached, sterile heads. Roots, crown and stem bases develop a brittle, brown-to-black rot. A superficial, coal-black mycelial mat forms just **under** the lower leaf sheaths. The fungus overseasons in soil as well as crop residue.

For chemical control suggestions, a listing of resistant varieties, and other control measures, consult the Extension Plant Pathologist at your land-grant university, or your county extension office.

Photo credits: D. C. Arny (1), J. A. Browning (2, 8, 11), BASF (3, 4, 5, 6, 13, 14, 15, 16R), T. M. Sjulin (7), University of North Dakota (9), University of Illinois (10L and C, 12, 17), The American Phytoaptholigical Society (10R), and University of Wisconsin (16L).

The Illinois Vocational Agriculture Service provides equal opportunities in programs and employment.

WORKSHEET #1

GROWING WHEAT

1. How does wheat rank in importance with other crops in the world?

2. How does wheat rank in importance in Illinois?

3. What are some of the common uses of hard red wheat? Of soft red wheat?

4. What factors should be considered when selecting a variety of wheat?

5. Can wheat be grown continuously on the same land each year in Illinois? Why?

6. Wheat serves as a good cover crop to reduce _______ and _____ during the winter. At the same time, it can be a valuable emergency pasture, especially in the southern part of the state.

7. Wheat fits into rotations that contain at least one legume and one or more ______________.

8. In recent years, wheat often has been more profitable after _________ than after _________, because soybeans are harvested earlier and the seedbed can be prepared with less ________. Usually all that is needed to prepare soybean land for wheat is a thorough disking.

9. What led to the increase in double cropping wheat and soybeans?

10. Commercial fertilizer is usually applied at seeding time by an attachment on the ____________.

11. Apply phosphorus in the soluble form since wheat is very sensitive to a shortage of phosphorus, especially in the ________ stages of growth.

12. Provide enough potassium in potash-deficient soils to meet the needs of _______ ________ where one is to be spring seeded in the wheat. Additions of potash also increase yields and standing abilities of wheat.

13. Apply 20 to 40 pounds of actual nitrogen per acre to wheat, on nitrogen deficient soils, in late ________ or early _______. Too much nitrogen may cause _____ and injury to the ____________.

14. The time and method of preparing the land for wheat depends mainly on the _________ that precedes it.

15. Where corn is harvested with mechanical pickers, the land preferably should be ________ to turn under cornstalks, which help control _______ and ________ that are in or on the stalks.

16. Wheat seed should not be sown unless it germinates at least _________.

17. Drilling _________ seed, ensures better _________ and more _________ stands reduces winter injury and almost always produces better _________.

18. Wheat is generally sown at the rate of __ to __ pecks per acre.

19. Covering seed from __ to __ inches is usually sufficient in a well prepared firm, moist seedbed.

20. Wheat should be sown early enough to become well ________ before winter, but not so early that it makes rank _______ or starts to _______ before winter.

21. Early sowings may become infested with ________ if the insect is prevalent. To avoid fall infestation of susceptible varieties of wheat by the Hessian fly, it is advisable to delay fall seeding until the ________ date.

22. The plants should be well ________ before pasturing begins; otherwise, they may be _______ by grazing animals. Livestock should be kept off the fields when the ground is ____ and ____.

23. _______ pasturing may be practiced under favorable conditions, but a loss in grain _______ should be expected. The loss is likely to be especially _______ if pasturing is permitted after plants begin to _______.

27. What insects attack growing wheat and how can they be controlled?

Insect	Symptoms	Method of Control

WORKSHEET #2

GROWING OATS

1. What are the 3 regions of Illinois used for making variety recommendations?

2. What is the minimum test weight for quality oats?

3. What are the benefits of chemically treating seed oats?

4. How is the seedbed for oats usually prepared?

5. When should spring oats be seeded for maximum yield?

6. What is the normal recommended seeding rate for oats?

7. What are the advantages of drilling oats over broadcasting?

9. Too much nitrogen will cause excess _____ and _______.

10. What are the advantages of winter oats in southern Illinois? Disadvantages?

11. What are the recommended seeding rates, seeding dates and varieties of winter oats?

12. What chemicals can be used to control weeds in winter oats?

13. What is the most troublesome insect pest in oats?

14. Barley yellow dwarf is a viral disease transmitted by aphids. What cultural practices can help prevent heavy damage from the disease?

15. What weather conditions are favorable for the spread of rust infections?

16. What are some prevention and control measures for rust diseases?

17. What parts of the plant does Septoria attack?

18. What are some ways to control it?

TEACHER'S KEY

WORKSHEET #1

GROWING WHEAT

(Reference-VAS Unit 4027a)

1. How does wheat rank with other crops in the world?

   It is the most important crop in the world.

2. How does wheat rank in Illinois?

   Third

3. What are some of the common uses of hard red wheat? Of soft red wheat?

   Hard red winter is used in making bread.

   Soft red winter is used in making cake, pastries, and general purpose cooking.

4. What factors should be considered when selecting a variety of wheat?

   a. winter hardiness
   b. yield
   c. quality
   d. resistance to lodging
   e. maturity date
   f. disease resistance

5. Can wheat be grown continuously on the same land each year in Illinois?

   It is possble, however it is not advisable or as profitable as using wheat as one part of a crop rotaton with one legume and one or more row crops.

6. Wheat serves as a good cover crop to reduce leaching and erosion during the winter. At the same time, it can be a valuable emergency pasture, especially in the southern part of the state.

7. Wheat fits into rotations that contain at least one legume and one or more row crops.

8. In recent years, wheat often has been more profitable after soybeans than after corn, because soybeans are harvested earlier and the seedbed can be prepared with less effort. Usually all that is needed to prepare soybean land for wheat is a thorough disking.

9. What led to the increase in double cropping wheat and soybeans?

    a. Thicker stand of wheat to control weeds
    b. earlier removal of wheat
    c. new developments in equipment
    d. new soybean herbicides
    e. higher soybean planting populations
    f. proper soybean maturity, fertility

10. Commercial fertilizer is usually applied at seeding time by an attachment on the grain drill.

11. Apply phosphorus in the soluble form since wheat is very sensitive to a shortage of phosphorus, especially in the early stages of growth.

12. Provide enough potassium in potash-deficient soils to meet the needs of forage legumes where one is to be spring seeded in the wheat. Additions of potash also increase yields and standing abilities of wheat.

13. Apply 20 to 40 pounds of actual nitrogen per acre to wheat, on nitrogen deficient soils, in late March or early April. Too much nitrogen may cause lodging and injury to the legume seedlings.

14. The time and method of preparing the land for wheat depends mainly on the crop that precedes it.

15. Where corn is harvested with mechanical pickers, the land preferably should be plowed to turn under cornstalks, which help control corn borer and scab fungus that are in or on the stalks.

16. Wheat seed should not be sown unless it germinates at least 90%.

17. Drilling saves seed, ensures better germination and more uniform stands reduces winter injury and almost always produces better yields.

18. Wheat is generally sown at the rate of 5 to 8 pecks per acre.

19. Covering seed from 1 to 1½ inches is usually sufficient in a well prepared firm, moist seedbed.

20. Wheat should be sown early enough to become well established before winter, but not so early that it makes rank growth or starts to shoot before winter.

21. Early sowings may become infested with Hessian fly if the insect is prevalent. To avoid fall infestation of susceptible varieties of wheat by Hessian fly, it is advisable to delay fall seeding until the safe date.

22. The plants should be well established before pasturing begins; otherwise, they may be uprooted by grazing animals. Livestock should be kept off the fields when the ground is wet and soft.

23. Spring pasturing may be practiced under favorable conditions, but a loss in grain yields should be expected. The loss is likely to be especially heavy if pasturing is permitted after plants begin to shoot.

24. List common annual and perennial weeds that often cause problems in wheat, and control methods for each.

Weeds	Control of Methods
	(refer to VAS 4027a, pages 15-17)

25. What are some cultural methods of controlling weeds in wheat?

(refer to VAS 4027a, page 17)

26. Why are chemical and cultural methods of weed control greatly influenced by underseeding with legumes.

Most legumes are susceptible to serious injury from herbicides.

27. What insects attack growing wheat and how can they be controlled?

Insect	Symptoms	Method of Control

TEACHER'S KEY

WORKSHEET #2

GROWING OATS

(Reference-VAS Unit 4023b)

1. What are the 3 regions of Illinois used for making variety recommendations?

   Northern, Central, Southern

2. What is the minimum test weight for quality oats?

   32 lbs/bu.

3. What are the benefits of chemically treating seed oats?

   refer to VAS 4023b p. 5

4. How is the seedbed for oats usually prepared?

   refer to VAS 4023b p. 7

5. When should spring oats be seeded for maximum yield?

   refer to VAS 4023b p. 7

6. What is the normal recommended seeding rate for oats?

   refer to VAS 4023b p. 7

7. What are the advantages of drilling oats over broadcasting?

   refer to VAS 4023b p. 8

8. How much nitrogen, phosphate, and potash is removed by each bushel of oats?

   1 bu. oats removes .61 lbs. of N, .25 lbs. of $P_2 0_5$ and .18 lbs. of $K_2 0$

9. Too much nitrogen will cause excess growth and lodging.

10. What are the advantages of winter oats in southern Illinois? Disadvantages?

    (refer to VAS 4023b Section 3)

11. What are the recommended seeding rates, seeding dates and varieties of winter oats?

(refer to VAS 4023b Section 3)

12. What chemicals can be used to control weeds in winter oats?

(refer to VAS 4023b Section 4)

13. What is the most troublesome insect pest in oats?

Spring grain aphids or greenbugs

14. Barley yellow dwarf is a viral disease transmitted by aphids. What cultural practices can help prevent heavy damage from the disease?

(refer to VAS 4023b p. 14)

15. What weather conditions are favorable for the spread of rust infections?

High humidity (fog, heavy dew), and warm temperatures

16. What are some prevention and control measures for rust diseases?

(refer to VAS 4023b p. 15)

17. What parts of the plant does Septoria attack?

leaves, stem or head

18. What are some ways to control it?

tolerant or resistant varieties
use of clean treated, certified seed
crop rotations; 3-4 years between oat crops

TEACHER'S KEY

SAMPLE TEST QUESTIONS

GROWING SMALL GRAINS

C 1. The three regions of Illinois used for making small grain varietal recommendations are:

   a. east, central, west
   b. northeast, northwest and southern
   c. northern, central, southern
   d. southeast, northeast, western

B 2. How much should good oats weigh per bushel?

   a. 30 lbs.
   b. 32 lbs.
   c. 40 lbs.
   d. 50 lbs.

D 3. Treating the seed of small grains will pay, because:

   a. it will prevent loss from weeds
   b. it will prevent insect damage
   c. yields will be 10-15 bushels per acre higher
   d. chemical seed treatments kill smuts and other diseases on the seed

A 4. When small grains follow soybeans in a crop rotation, the seedbed is usually prepared by:

   a. disking
   b. plowing and disking
   c. chisel plowing
   d. no-till

D 5. To get small grains off to a fast start, apply:

   a. rock phosphate early in the season
   b. anhydrous ammonia early in the season
   c. organic matter early in the season
   d. soluble phosphate early in the season

D 6. Small grains are often grown as:

   a. a cash crop
   b. a nurse crop for legumes
   c. a cover crop to prevent erosion
   d. all of the above

B 7. Typical seeding rates would be

a. 1½ bu/acre for oats and 2½ bu./acre for wheat
b. 2½ bu/acre for oats and 1½ bu/acre for wheat
c. 4 bu/acre for each
d. ½ bu/acre for each

C 8. Drilling is the preferred method of seeding because:

a. it is faster than broadcasting
b. it can be done earlier in the season
c. it provides a more uniform seeding depth
d. it allows the use of more seed per acre

A 9. Wheat should be seeded:

a. after the fly-free date
b. immediately after soybean harvest
c. immediately after corn harvest
d. by the end of August

C 10. Where can winter oats be sown in Illinois?

a. only in the northernmost areas
b. only in the southern tip
c. south of route 50 in normal winters
d. anywhere in Illinois in normal winters

A 11. Which of the following is not a type of wheat commonly grown in Illinois?

a. amber durum wheat
b. hard red spring wheat
c. hard red winter wheat
d. soft red winter wheat

D 12. What weeds cause the most problems in wheat and other small grains?

a. Wild Mustard
b. Canada Thistle
c. Field Bindweed
d. Wild Garlic and Wild Onion

B&D 13. Which of the following are cultural methods of controlling weeds in small grains? (Multiple answers)

a. planting winter grains after first frost
b. planting weed-free seed
c. underseed wheat with legumes
d. time the tillage to prevent weed seed formation

B 14. Which of the following insect problems is not easily controlled with chemicals?

a. Grasshoppers
b. Hessian Fly
c. Armyworm
d. Chinch bugs

C 15. How is the disease Barley Yellow Dwarf spread?

a. wind carries spores
b. plants rub the disease on others in wind
c. aphids carry viruses
d. disease organisms are in soil

True-False

F 16. Large amounts of nitrogen in the starter fertilizer contribute to strong, stiff straw and reduced losses from lodging.

T 17. Special care should be taken when using herbicides on wheat underseeded with legumes.

F 18. The wheat can be pastured with little reduction in yield if done in the spring after the plants begin to shoot.

F 19. It is advisable and profitable to grow wheat continuously on the same land each year in Illinois.

T 20. Double cropping has become more common with the advent of early maturing wheat and soybean varieties.

21. Essay: Name four characteristics to consider when selecting a variety of small grains

22. Essay: Name four practices which can be used to control diseases of small grains.

UNIT CROP SCIENCE

PROBLEM AREA: HARVESTING FARM CROPS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth grade or second year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is in the fall during the harvesting season. The estimated time for teaching this problem area is 8 to 10 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. Students have received basic instruction on growing soybeans, corn, and small grains.
2. Students will have the opportunity to visit area soybean and corn fields to observe soybean and corn harvesting.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts this problem area for his/her local situation.

CREDIT SOURCES:

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The teacher's guide, worksheets, and job sheets were developed by Richard Schertz, Vocational Agriculture Instructor, Moweaqua High School, Moweaqua, Illinois, and Jerry Pepple, Department of Vocational and Technical Education, University of Illinois. The transparency masters and soybean, corn, and small grain harvesting forms were prepared by Vocational Agriculture Service, University of Illinois.

Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Crop science

II. Problem area: Harvesting farm crops

III. Objectives: At the close of this problem area students will be able to:

1. Identify and explain each operation of a self propelled combine.
2. Identify different types of combines.
3. Understand the importance of figuring harvesting losses.
4. Know how to determine harvesting losses in corn, soybeans, and small grains.
5. Determine ways to reduce harvesting losses.

IV. Suggested interest approaches:

1. At harvesting time, conduct a field trip to a field where harvesting is being done.
2. Invite a guest speaker to discuss combine operation and adjustment.
3. Conduct a field trip to a local machinery dealership or farm and inspect a combine.
4. Have students check their parents' fields for crop losses.

V. Anticipated problems and concerns of students:

1. How are field losses estimated?
2. At what percent moisture should different crops be harvested?
3. What adjustments are made to a combine to reduce losses?
4. Where can I find information on how to adjust combines?
5. Do some types of combines do a better job of combining?
6. What method of harvesting is commonly used in the community?

VI. Suggested learning activities and experiences:

1. Use Worksheet 1, the transparency on "Grain Harvesting Unit," and supplemental references to explain each part and operation of a common combine. Use VAS Unit 3047, Introduction to Combines, for reference.
2. Take field trip and see a combine, using Worksheet 2. (Note: this worksheet is for a common perpendicular cylinder with raspbars.)
3. Acquire sales brochures from machinery dealers of other types of combines. Then identify information about combine specification, compare differences.
4. Discuss why figuring harvesting losses are so important. Use selected transparencies to reinforce important reasons.
5. Figure harvesting losses for corn (Worksheets 3 & 4), soybeans (Worksheets 5 & 6), and small grains (Worksheets 7 & 8).
6. Conduct field trips to figure actual harvesting losses. Use Job Sheets #1, 2, and 3.
7. Discuss ways to reduce harvesting losses. (VAS 3049.) Use class discussion or small groups to identify ways harvest losses can be minimized. Use Job Sheet #4 to emphasize proper grain moisture for harvesting.

VII. Evaluation:

1. Collect and grade worksheets.
2. Collect and grade selected job sheets in figuring harvesting losses.
3. Grade test at end of problem area.

VIII. References and aids:

1. VAS Unit 3049, Combines-Reducing Harvesting Losses, VAS, University of Illinois.
2. VAS Unit 3048, Combines Selection and Servicing, VAS, University of Illinois.
3. VAS Unit 3047, Introduction to Combines, VAS, University of Illinois.
4. Leaflets "Measuring Corn Losses"
   "Measuring Soybean Losses"
   "Measuring Small Grain Losses"

Supplementary References:

1. Deere and Company, 1981, Fundamentals of Machine Operation, Combine Harvesting, Second Edition.

STUDENT WORKSHEET #1

DETERMINING GRAIN HARVEST LOSSES

1. Name and describe the four types of header losses.

2. How fast should the reel speed be when harvesting soybeans? Why?

3. Where is preharvest loss measured?

4. Where are gathering unit losses measured?

5. How can cylinder and separating losses be determined?

WORKSHEET 1

PARTS OF A COMBINE

Using the transparency, "Grain Harvesting Unit," identify each numbered part and briefly. Describe its function.

	PART	FUNCTION
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

WORKSHEET 2

FIELD TRIP
COMBINES

Name ____________________

1. Make ____________________ Model ____________________

2. Type of Head ________________ Width ________________

3. Does this combine have a floating cutterbar? ________________

   How can you tell if a head has a floating cutter bar?

4. How is the reel or corn snap rollers turned? ________________

   ____

5. Is the reel a slat type or pickup type? ________________

6. Is the reel fore and aft adjustment mechanical or remote controlled?

   ____

   How about the reel height adjustment? ________________

7. How many row cornhead is used or can be used on this combine?

   ____

8. How many feeder chain sections are across the feeder throat? ____

9. Cylinder type? ____________ Type of beater? ____________

10. How many sections of straw walkers? ________________

11. How many holes across one section of straw walker? ____________

12. Does the machine have an (auger) or (return pan) at the end of the straw walker?

13. Where is the clean grain fan located on the combine? (You are in the driver's seat).

14. How many augers in the grain tank? ________________

15. What drives the cylinder? ____________________

16. Where are the concaves adjusted? ____________________

17. Size of the front tires? __________ rear tires? __________

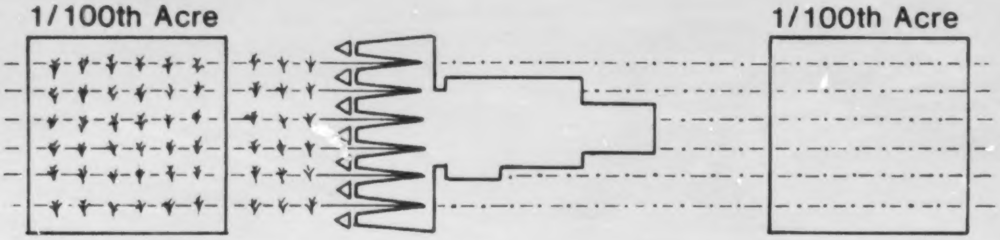
18. Does this combine have a straw spreader? ____________________

19. Why is leasing a combine more of an advantage to some people than buying?

20. How many steps are on the entrance ladder? ____________________

WORKSHEET 3

FIGURING CORN HARVESTING LOSSES

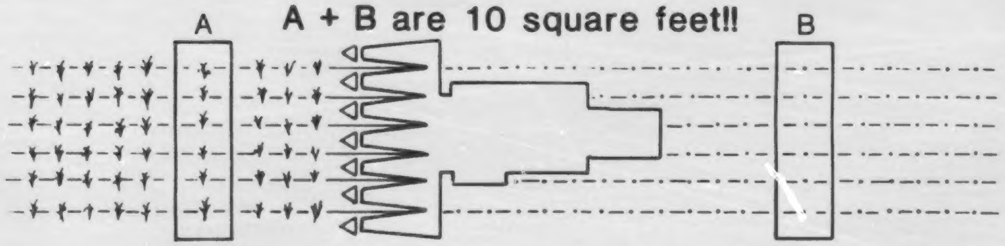


Area A	Area B
2-3/4 lb. ears	4-3/4 lb. ears
6-1/2 lb. ears	6-1/2 lb. ears
No broken ears	No broken ears

Harvesting Losses

1.	Total Ear Loss (behind machine)	____________	Bu./Acre
2.	Pre-harvest loss	____________	Bu./Acre
3.	Corn head loss	____________	Bu./Acre

A + B are 10 square feet!!



200 loose kernels

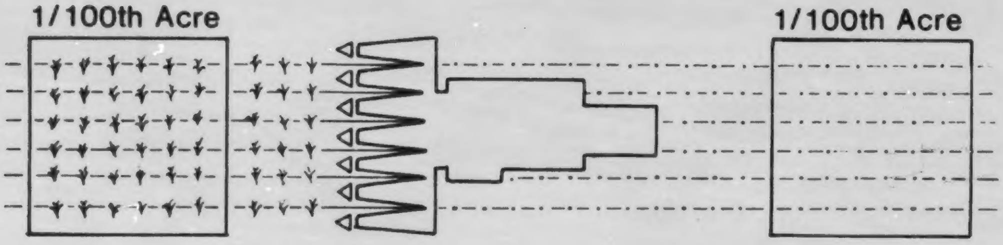
600 loose kernels
100 kernels on partially shelled cobs

Determining Total Kernel Loss

Record kernel losses	No. of kernels/ sq. ft. counted		No. of kernels/ sq. ft. = 1 bu./A	Loss bu./A
1. Loose kernel loss behind combine	____________	÷	2	= ________
2. Loose kernel loss (Snapping rolls)	____________	÷	2	= ________
3. Separator and shoe loss (No. 1 minus No. 2)	____________	÷	2	= ________
4. Cylinder loss (Kernels on partially shelled cobs)	____________	÷	2	= ________
5. Total loss/acre (Add lines 2, 3, 4)				= ________
6. Total ear loss/acre (Line 3, Harvesting Losses)				= ________
7. Total corn harvesting loss (Line 5 + Line 6)				= ________

Worksheet 4

FIGURING CORN HARVESTING LOSSES



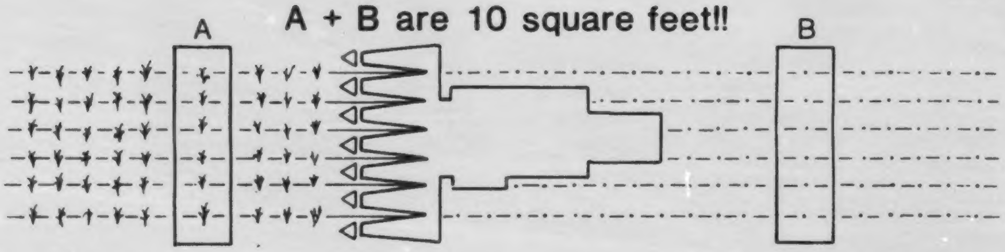
Area A
6-3/4 lb. ears
No 1/2 lb. ears
No broken ears

Area B
6-3/4 lb. ears
No 1/2 lb. ears
No broken ears

Harvesting Losses

1. Total Ear Loss (behind machine) ____________ Bu./Acre
2. Pre-harvest loss ____________ Bu./Acre
3. Corn head loss ____________ Bu./Acre

A + B are 10 square feet!!



500 loose kernels

600 kernels
20 kernels on partially shelled cobs

Determining Total Kernel Loss

Record kernel losses	No. of kernels/ sq. ft. counted		No. of kernels/ sq. ft. = 1 bu./A		Loss bu./A
1. Loose kernel loss behind combine	____________	÷	2	=	____________
2. Loose kernel loss (Snapping rolls)	____________	÷	2	=	____________
3. Separator and shoe loss (No. 1 minus No. 2)	____________	÷	2	=	____________
4. Cylinder loss (Kernels on partially shelled cobs)	____________	÷	2	=	____________
5. Total loss/acre (Add lines 2, 3, 4)				=	____________
6. Total ear loss/acre (Line 3, Harvesting Losses)				=	____________
7. Total corn harvesting loss (Line 5 + Line 6)				=	____________

WORKSHEET 5

COMBINES - REDUCING HARVESTING LOSSES

Name ______________________

Figure the soybean loss using the data on attached page.

Sources of Loss	Column A Beans found in 1 sq. ft. Area	Number of Beans to = 1 bu./acre	Bean Loss in bu./acre	Total
1. Total Crop Loss	________	÷ 4	________	
2. Pre-Harvest Loss	________	÷ 4	________	
3. Machine Loss (Line 1 minus Line 2)				____
4. Gathering Unit Loss Total of: (From Area B)				
a. Shatter	________	÷ 4	________	
(Loose beans--pre-harvest loss)	________	÷ 4	________	
b. Loose pod (Loose pod--pre-harvest pod)	________	÷ 4	________	
c. Loose stalk (Not attached to plant)	________	÷ 4	________	
d. Lodged stalk (Attached to ground)	________	÷ 4	________	
e. Stubble (Pods attached to stubble)	________	÷ 4	________	
f. Total gathering unit loss (Total line a through line e)				____
5. Cylinder and Separation Loss Machine loss (line 3) minus Header loss (line 4f)				____

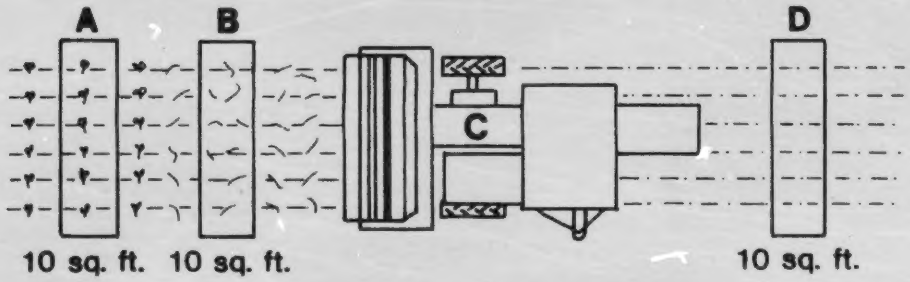
A = 62 beans

B = Loose stalk-29 beans, Shatter-142 beans, Stubble-22 pods x 3 beans/ per pod = 66 beans, Lodged stalk - 0, Pods - 0.

C = 194.8 beans.

D = 432 beans.

The soybean yield for this field is 45 bu. per acre. How efficient is this combine? 65.5% 75% 79.4% 83.2%



Note: These counts must be divided by 10 to get 1 sq. ft. for Column A.

WORKSHEET 6

COMBINES - REDUCING HARVESTING LOSSES

Name ______________________

Figure the combine soybean loss using the data on attached page.

Source of Loss	Column A Beans found in 1 sq. ft. Area	Number of Beans to = 1 bu./acre	Beans loss in bu./acre	Total
1. Total Crop Loss (Area D)	______	÷ 4	______	
2. Pre-Harvest Loss (Area A)	______	÷ 4	______	
3. Machine Loss (Line 1 minus Line 2)				______
4. Gathering Unit Loss Total of: (From Area B)				
a. Shatter (Loose beans--preharvest loss)	______	÷ 4	______	
b. Loose pod (Loose pod--pre-harvest pod)	______	÷ 4	______	
c. Loose stalk (Not attached to plant	______	÷ 4	______	
d. Lodged stalk (Attached to ground)	______	÷ 4	______	
e. Stubble (Pods attached to stubble)	______	÷ 4	______	
f. Total gathering unit loss (Total line a through line e)				______
5. Cylinder and Separation Loss Machine loss (line 3) minus Header loss (line 4f)				______

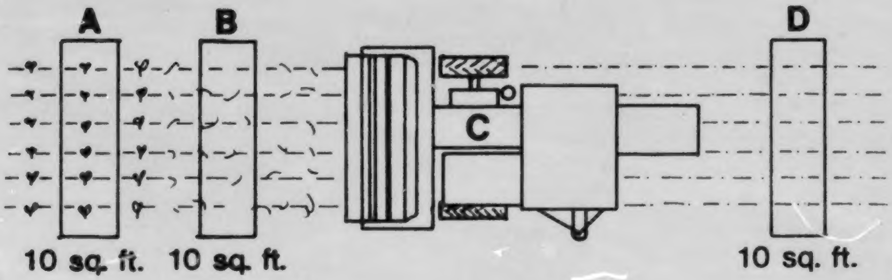
A = 14 pods, 231 loose beans = 273 total beans.

B = Shatter 295 beans, Loose pods 16 with 48 beans, Loose stalk with 40 pods X 3 = 120 beans, Lodged stalk - one with 40 beans.

C = 5.2 beans.

D = 466 beans.

Is the combine in acceptable loss limits? ____________________



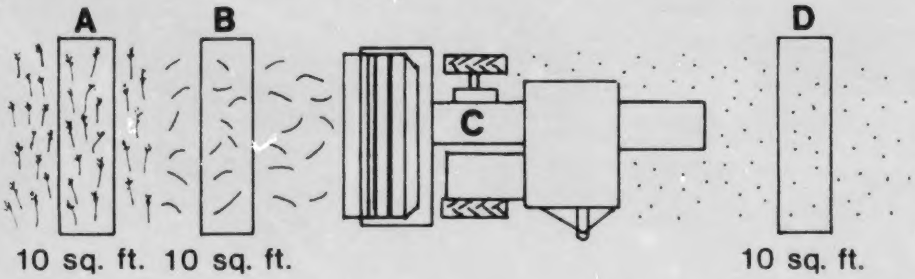
Note: These counts must be divided by 10 to get 1 sq. ft. for Column A.

WORKSHEET 7

DETERMINING SMALL GRAIN LOSSES

Source of Loss	Kernels of grain/ 1 sq. ft.		No. of grains/ sq. ft. to = 1 bu/A*		Loss bu./A	Acceptable loss/acre
1. Grain loss (behind combine) (Area D)		÷		=		
2. Pre-harvest loss (Area A)		÷		=		
3. Total machine loss				=		
4. Header and pre-harvest loss (Area B)						
5. Header loss (B-A)		÷		=		
6. Cylinder and separation loss				=		

*Wheat--20 grains; Barley--15 grains, Oats--12 grains; Rye--24 grains.



WHEAT HARVEST

A = 275 loose grains or loose heads.

B = 400 loose grains or loose heads.

C = 224 loose grains or loose heads.

D = 625 loose grains or loose heads.

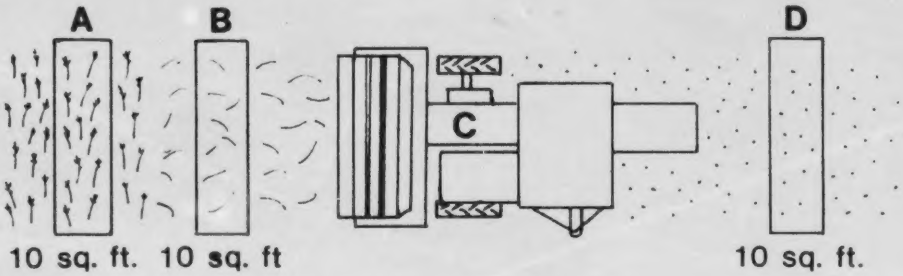
Note: These counts must be divided by 10 to get 1 sq. ft. for first column.

WORKSHEET 8

SMALL GRAINS LOSSES

Source of Loss	Kernels of grain/ 1 sq. ft.		No. of grains/ sq. ft. to = 1 bu/A*		Loss bu./A	Acceptable loss/acre
1. Grain loss (behind combine) (Area D)	______	÷	______	=	______	______
2. Pre-harvest loss (Area A)	______	÷	______	=	______	______
3. Total machine loss				=	______	______
4. Header and pre-harvest loss (Area B)	______					
5. Header loss (B-A)	______	÷	______	=	______	______
6. Cylinder and separation loss				=	______	______

*Wheat--20 grains; Barley--15 grains; Oats--12 grains; Rye--24 grains.



WHEAT HARVEST

A = 200 loose grains or loose heads.

B = 300 loose grains or loose heads.

C = 100 loose grains or loose heads.

D = 400 loose grains or loose heads.

Note: These counts must be divided by 10 to get 1 sq. ft. for first column.

STUDENT JOB SHEET #1

DETERMING TOTAL EAR LOSS

I. Measure ear loss ahead of combine

Procedure: Mark off 1/100 of an acre, pick up ears on the ground, separate the ears according to size.

Note: Each 3/4 ear represents 2 bushel loss/acre.

II. Measure ear loss behind the combine

Procedure: Mark off 1/100 of an acre, count ears on the ground, separate the ears according to size, determine bushels lossed per acre.

Total Ear Loss ______________ Bus/acre
(behind machine)

Pre-harvest loss ______________ Bus/acre

Corn head loss ______________ Bus/acre
(Total ear loss at back of corn head - pre-harves loss)

More information refer to leaflet "Measuring Corn Losses"

III. Conclusions: Is this combine efficiently adjusted? Identify how losses could be reduced.

STUDENT JOB SHEET #2

DETERMINING TOTAL KERNEL LOSS

I. Procedure:

1. Count kernels behind the machine
    - a. Measure off 10 sq. feet
    - b. Count loose kernels
    - c. Divide by 10 to get kernels of loss per sq. ft.
2. Count Snapping Roll Loss
    - a. Measure off 10 sq. feet in front of the machine between the head and standing corn
    - b. Count losse kernels
    - c. Divide by 10
3. Separator and Shoe loss.
    - a. Subtract snapping roll loss/sq. ft. from the loose kernel loss per square foot determined at the rear of the combine.

II. Complete the following:

	No. of kernels/ sq. ft. counted		No. of Kernels sq. ft. = 1bu./A		Loss bu./A
1. Loose kernel loss behind combine	_____	÷	2	=	__________
2. Loose kernel loss (Snapping rolls)	_____	÷	2	=	__________
3. Separator and shoe loss (No. 1 - No. 2)	_____	÷	2	=	__________
4. Cylinder loss (Kernels on partially shelled cobs)	_____	÷	2	=	__________
5. Total loss/acre (Add lines 2, 3, 4)	_____	÷	2	=	__________
6. Total ear loss/acre (Refer to Total Ear Loss Job Sheet	_____	÷	2	=	__________
7. Total Corn harvesting loss (Line 5 + line 6)	_____	÷	2	=	__________

For more information refer to VAS 3049 Reducing Harvesting Losses.

III. Conclusions:

JOB SHEET #3

MEASURING SOYBEAN LOSSES

A. Objectives: To evaluate the efficiency of a soybean combine and determine soybean loss areas in the combine.

B. Materials:

1. Following references from Vocational Agricultural Service, University of Illinois:
   a. VAS Unit 3049 Combines-Reducing Harvesting Losses.
   b. One page leaflet a Supplement to VAS 3049, "Combines - Reducing Harvesting Losses."

C. Procedures:

1. Take a field trip to observe a combine harvesting soybeans and determine combine materials efficiency.

D. Student Job Sheet

Refer to Table 2 in leaflet "Measuring Soybean Losses."

E. Analyze Loss Data:

1. Where is the largest loss occurring? How can this problem be corrected?

2. Where is the second largest loss of grain occurring?

3. Where is the smallest loss of grain occurring? Explain why.

Answers can be found in part 3 of VAS Unit 3049.

Answers will depend on the different combine operators. Every field trip will have a different set of answers.

JOB SHEET #4

MOISTURE TESTING CORN AND SOYBEANS

I. Equipment: Shelled Corn Moisture Tester

II. General Operating Instructions: (Refer to Operator Manual for exact procedures)

1. Detemine if the moisture tester is precalibrated to read-out the moisutre content of corn.
2. For maximum precision place the moisture tester in a steady, level position.
3. Pour the sample to be tested into the testing chamber slowly, at a constant rate-approximately 10-12 seconds, using the pouring cup, until a reading appears.
4. Read moisture content of corn directly, refer to chart for other grains.
5. To compensate for difference in temperature of the grain, wait 15 seconds and push the temperature compensation button. Read the temperature compensated moisture content of corn directly; refer to chart for other grains.
6. To empty sample, simply turn over the tester.

Corn Moisture ______________________________

III. Conclusions: Would you recommend harvesting if this sample was from your SOEP? Why? Why not?

TEACHER'S KEY

STUDENT WORKSHEET #1

DETERMINING GRAIN HARVEST LOSSES

1. Name and describe the four types of header losses.

   Shatter - beans or pods shattered from the stalks and fall to the ground.

   Stubble - pods left on the standing stubble.

   Lodged - pods attached to down stalks cut at lengths greater than stubble height.

   Stalk - pods attached to cut stalks which fail to reach the combine.

2. How fast should the reel speed be when harvesting soybeans?

   25% greater than the combine ground speed.

3. Where is preharvest loss measured?

   Across the rows of standing beans in front of the combine.

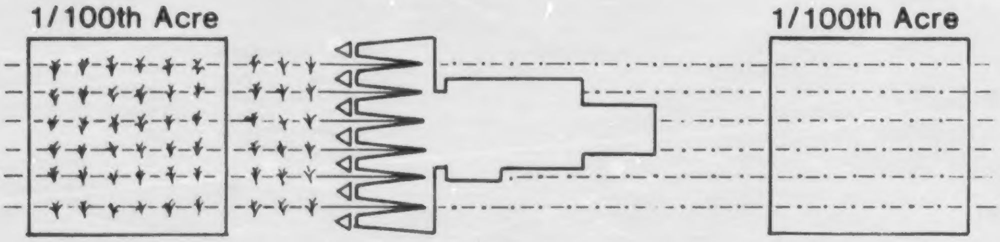
4. Where is gathering unit losses measured?

   In front of the combine drive wheels.

5. How can cylinder and separating losses be determined?

   By subtracting gathering losses from total harvesting losses.

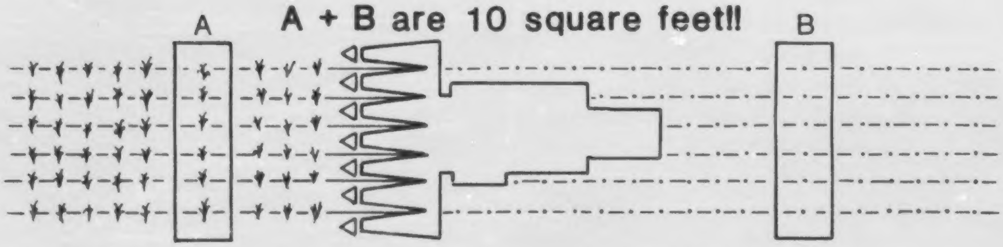
FIGURING CORN HARVESTING LOSSES



Area A	**Area B**
2-3/4 lb. ears	**4-3/4 lb. ears**
6-1/2 lb. ears	**6-1/2 lb. ears**
No broken ears	**No broken ears**

Harvesting Losses

1.	Total Ear Loss (behind machine)	8	Bu./Acre
2.	Pre-harvest loss	6	Bu./Acre
3.	Corn head loss	2	Bu./Acre



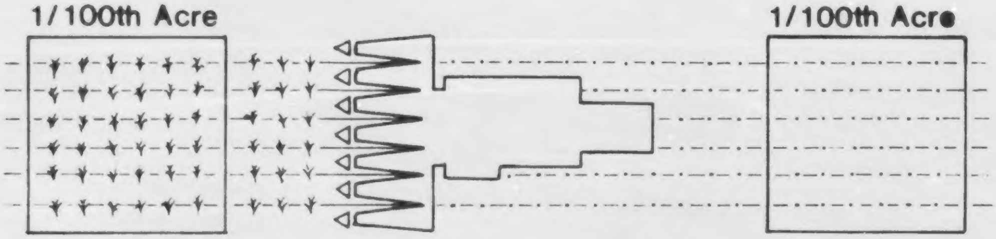
200 loose kernels	**600 loose kernels** **100 kernels on partially shelled cobs**

Determining Total Kernel Loss

Record kernel losses	No. of kernels/ sq. ft. counted		No. of kernels/ sq. ft. = 1 bu./A		Loss bu./A
1. Loose kernel loss behind combine	60	÷	2	=	30
2. Loose kernel loss (Snapping rolls)	20	÷	2	=	10
3. Separator and shoe loss (No. 1 minus No. 2)	40	÷	2	=	20
4. Cylinder loss (Kernels on partially shelled cobs)	10	÷	2	=	5
5. Total loss/acre (Add lines 2, 3, 4)				=	35
6. Total ear loss/acre (Line 3, Harvesting Losses)				=	2
7. Total corn harvesting loss (Line 5 + Line 6)				=	37

TEACHER'S KEY – WORKSHEET 4

FIGURING CORN HARVESTING LOSSES

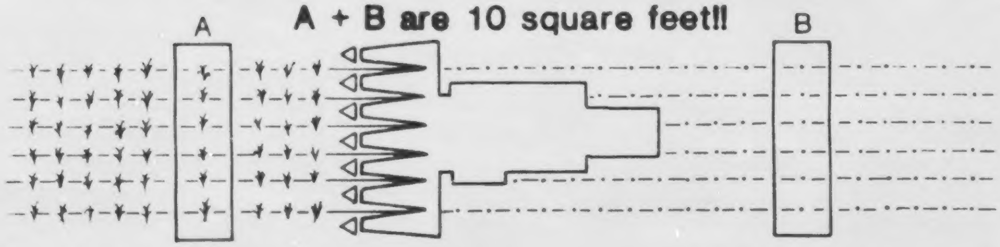


Area A
6-3/4 lb. ears
No 1/2 lb. ears
No broken ears

Area B
6-3/4 lb. ears
No 1/2 lb. ears
No broken ears

Harvesting Losses			
1.	Total Ear Loss (behind machine)	6	Bu./Acre
2.	Pre-harvest loss	6	Bu./Acre
3.	Corn head loss	0	Bu./Acre

A + B are 10 square feet!!



500 loose kernels

600 kernels
20 kernels on partially shelled cobs

Determining Total Kernel Loss

	Record kernel losses	No. of kernels/ sq. ft. counted		No. of kernels/ sq. ft. = 1 bu./A		Loss bu./A
1.	Loose kernel loss behind combine	60	÷	2	=	30
2.	Loose kernel loss (Snapping rolls)	50	÷	2	=	25
3.	Separator and shoe loss (No. 1 minus No. 2)	10	÷	2	=	5
4.	Cylinder loss (Kernels on partially shelled cobs)	2	÷	2	=	1
5.	Total loss/acre (Add lines 2, 3, 4)				=	31
6.	Total ear loss/acre (Line 3, Harvesting Losses)				=	0
7.	Total corn harvesting loss (Line 5 + Line 6)				=	31

TEACHER'S KEY

WORKSHEET 5

COMBINES - REDUCING HARVESTING LOSSES

Name ______________________

Figure the soybean loss using the data on attached page.

Sources of Loss	Column A Beans found in 1 sq. ft. Area	Number of Beans to = 1 bu./acre	Bean loss in bu./acre	Total
1. Total Crop Loss (Area D ÷ 10)	43.2	÷ 4	10.8	
2. Pre-Harvest Loss (Area A ÷ 10)	6.2	÷ 4	1.55	
3. Machine Loss (Line 1 minus Line 2)				9.25
4. Gathering Unit Loss Total of: (from Area B)				
a. Shatter (Loose beans-preharvest loss) (142-62=80)	8.0	÷ 4	2.0	
b. Loose pod (Loose pod-preharvest pod)	0	÷ 4	0	
c. Loose stalkd (Not attached to plant)	2.9	÷ 4	.73	
d. Lodged stalk (Attached to ground)	0	÷ 4	0	
e. Stubble (Pods attached to stubble)	6.6	÷ 4	1.65	
f. Total gathering unit loss (Total line a through line e)				4.38
5. Cyclinder and Separation Loss Machine loss (line 3) minus Header loss (line 4f)				4.87

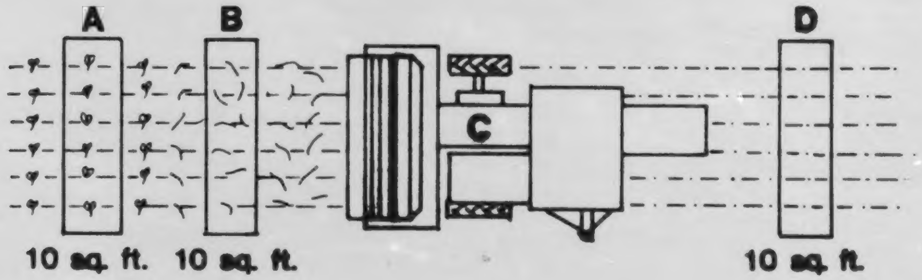
A = 62 beans

B = Loose stalk-29 beans, Shatter-142 beans, Stubble-22 pods=66 bean, Lodged stalk - 0, Loose pod - 0.

C = 194.8 beans.

D = 432 beans.

The soybean yield for this field is 45 bu. per acre. How efficient is this combined? 65.5% 75% 79.4% 83.2%



Note: These counts must be divided by 10 to get 1 sq. ft. for Column A.

TEACHER'S KEY

WORKSHEET 6

COMBINES - REDUCING HARVESTING LOSSES

Figuring Soybean Harvesting Losses, refer to data on attached page.

Source of Loss	Column A Beans found in 1 sq. ft. Area	Number of Beans to = 1 bu./acre	Bean loss in bu./acre	Total
1. Total Crop Loss (Area D)	46.6	÷ 4	11.65	
2. Pre-Harvest Loss (Area A)	27.3	÷ 4	6.83	
3. Machine Loss (Line 1 minus Line 2)				4.83
4. Gathering Unit Loss Total of: (from Area B)				
a. Shatter (Loose beans--preharvest loss) 295-273=22	2.2	÷ 4	.55	
b. Loose pod (Loose pod-pre-harvest loss) 16-14=2 pods x 3 beans = 6	.6	÷ 4	.15	
c. Loose stalk (Not attached to plant)	12	÷ 4	3.0	
d. Lodged stalk (Attached to ground)	4.0	÷ 4	1.0	
e. Stubble (Pods attached to stubble)	0	÷ 4	0	
f. Total gathering unit loss (Total line a through line e)				4.70
5. Cylinder and Separation Loss Machine loss (line 3) minus Header loss (line 4f)				.13

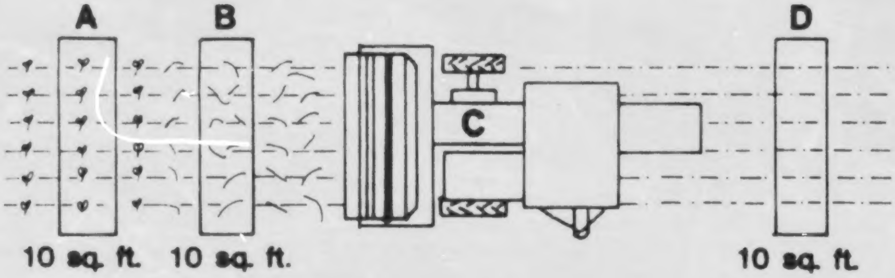
A = 14 pods, 231 loose beans = 273 total beans

B = Shatter 295 beans, Loose pods 16 with 48 beans total, Loose stalk with 40 pods X 3 = 120 beans, Lodged stalk-one with 40 beans.

C = 5.2 beans.

D = 466 beans.

Is the combine in acceptable loss limits? (3-5% of yield per acre) yes



Note: These counts must be divided by 10 to get 1 sq. ft. for Column A.

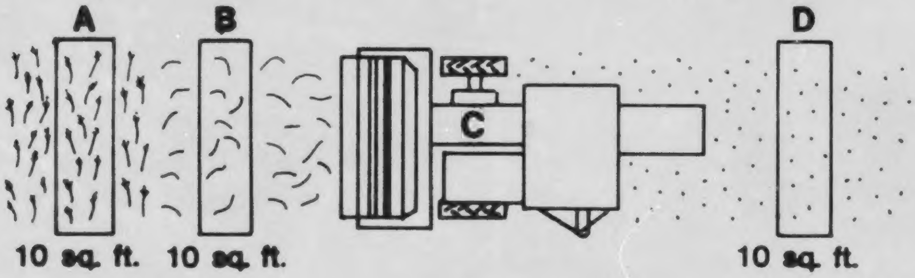
TEACHER'S KEY

WORKSHEET 7

DETERMINING SMALL GRAIN LOSSES

Source of Loss	Kernels of grain/ 1 sq. ft.		No. of grains/ sq. ft. to = 1 bu/A*		Loss bu./A	Acceptable loss/acre
1. Grain loss (behind combine) (Area D)	62.5	÷	20	=	3.13	
2. Pre-harvest loss (Area A)	27.5	÷	20	=	1.38	
3. Total machine loss				=	1.75	
4. Header and pre-harvest loss (Area B)	40.0					
5. Header loss (B-A)	12.5	÷	20	=	.63	
6. Cylinder and separation loss				=	1.12	

*Wheat--20 grains; Barley--15 grains; Oats--12 grains; Rye--24 grains.



WHEAT HARVEST

A = 275 loose grains or loose heads.

B = 400 loose grains or loose heads.

C = 224 loose grains or loose heads.

D = 625 loose grains or loose heads.

Note: These counts must be divided by 10 to get 1 sq. ft. for final column.

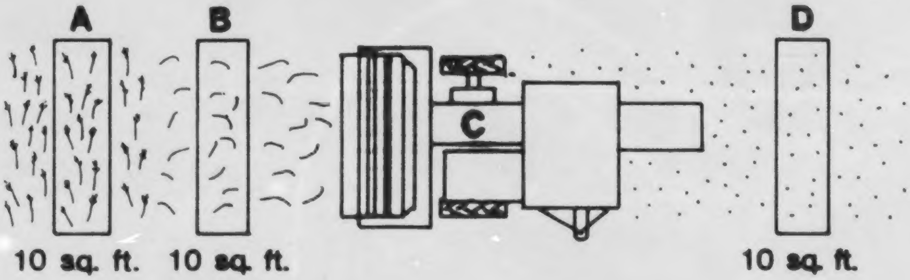
TEACHER'S KEY

WORKSHOP 8

SMALL GRAIN LOSSES

Source of Loss	Kernels of grain/ 1 sq. ft.		No. of grains/ sq. ft. to = 1 bu/A*		Loss bu./A	Acceptable loss/acre
1. Grain loss (behind combine) (Area D)	40	÷	20	=	2.0	
2. Pre-harvest loss (Area A)	20	÷	20	=	1.0	
3. Total machine loss				=	1.0	
4. Header and pre-harvest loss (Area B)	30					
5. Header loss (B-A)	10	÷	20	=	.5	
6. Cylinder and separation loss				=	.5	

*Wheat--20 grains; Barley--15 grains; Oats--12 grains; Rye--24 grains.



WHEAT HARVEST

A = 200 loose grains or loose heads.

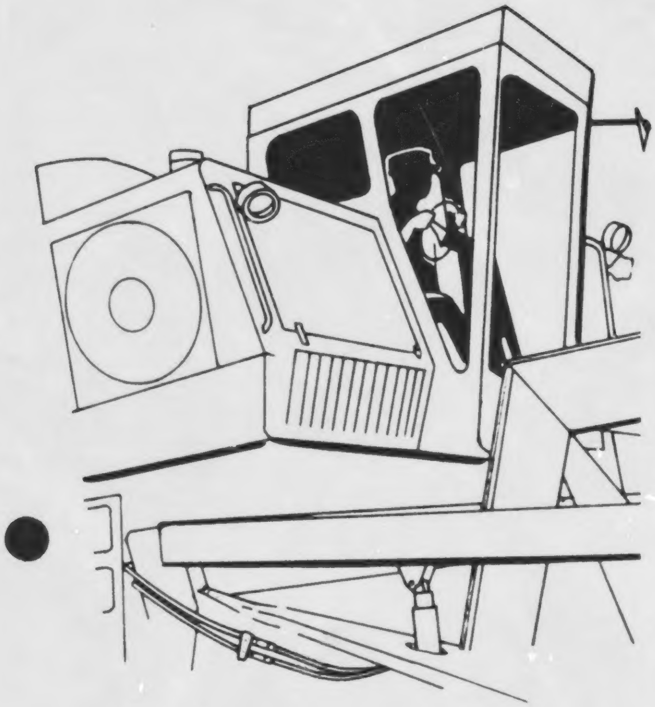
B = 300 loose grains or loose heads.

C = 100 loose grains or loose heads.

D = 400 loose grains or loose heads.

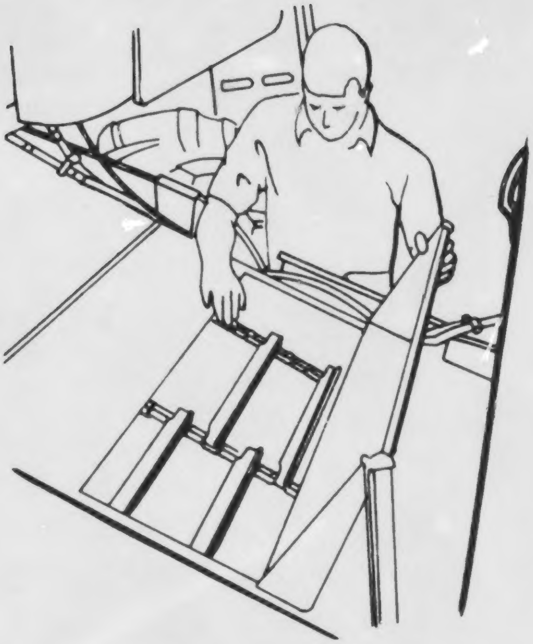
Note: These counts must be divided by 10 to get 1 sq. ft. for first column.

'DRIVER'



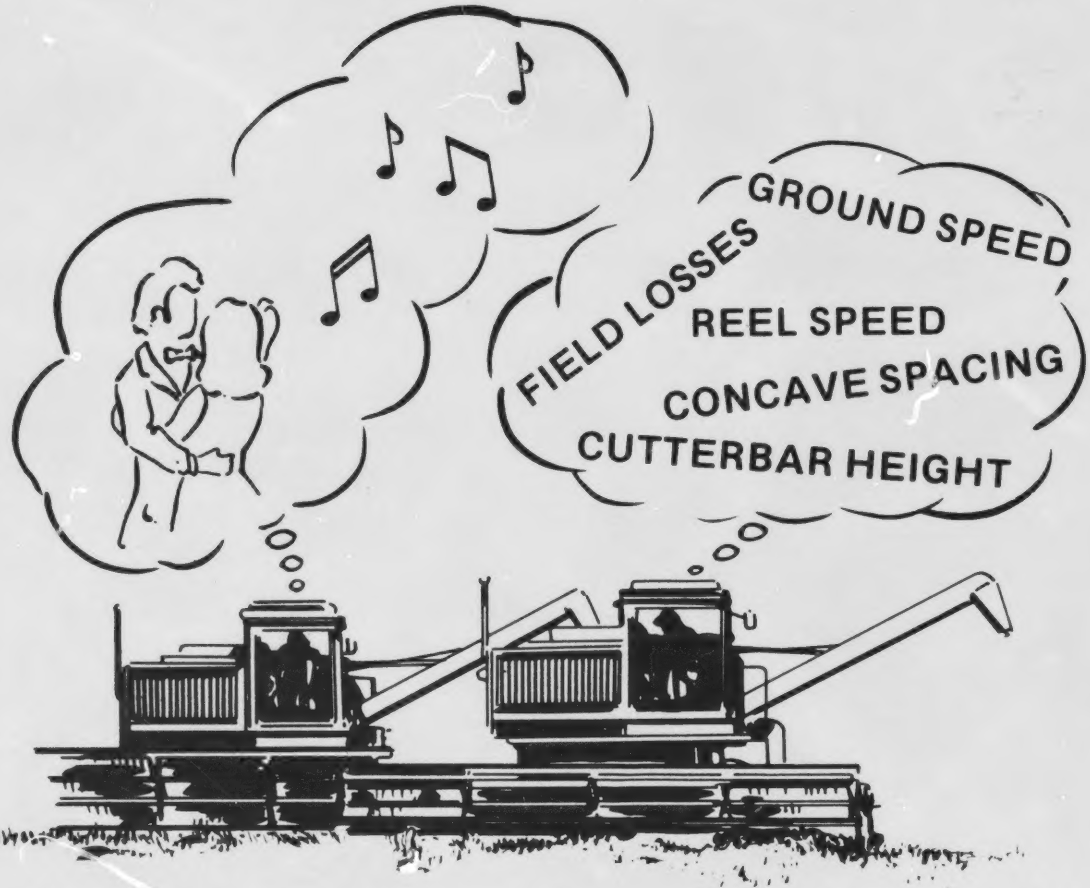
"I have combined 50 acres today and never left the operator's cab."

'OPERATOR'



"If I spend a few minutes checking and adjusting the combine, I might be able to save five bushels or more per acre."

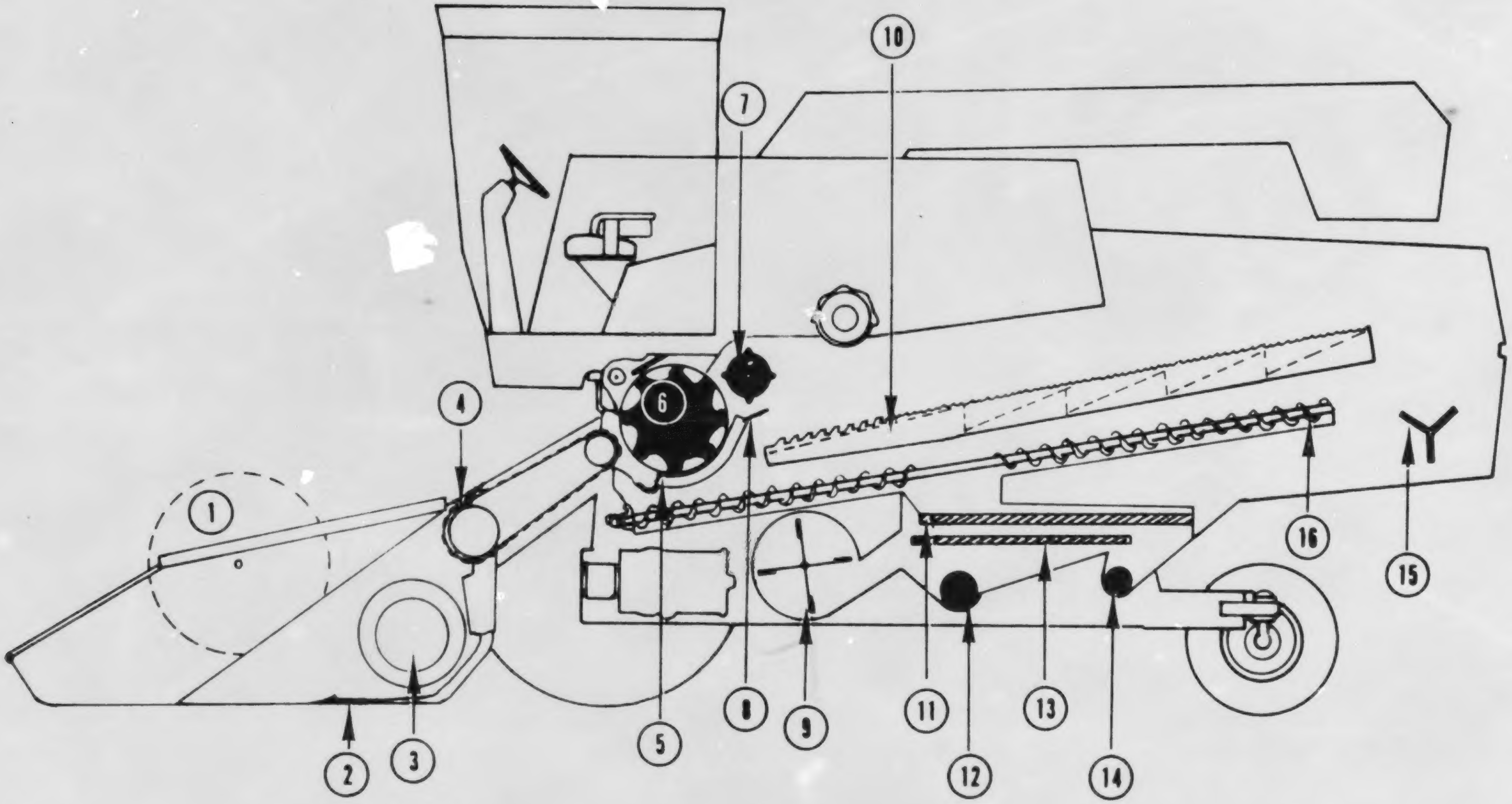
DIFFERENCES
BETWEEN A DRIVER AND AN OPERATOR


GROUND SPEED
FIELD LOSSES
REEL SPEED
CONCAVE SPACING
CUTTERBAR HEIGHT

**COMBINE
"DRIVER"**

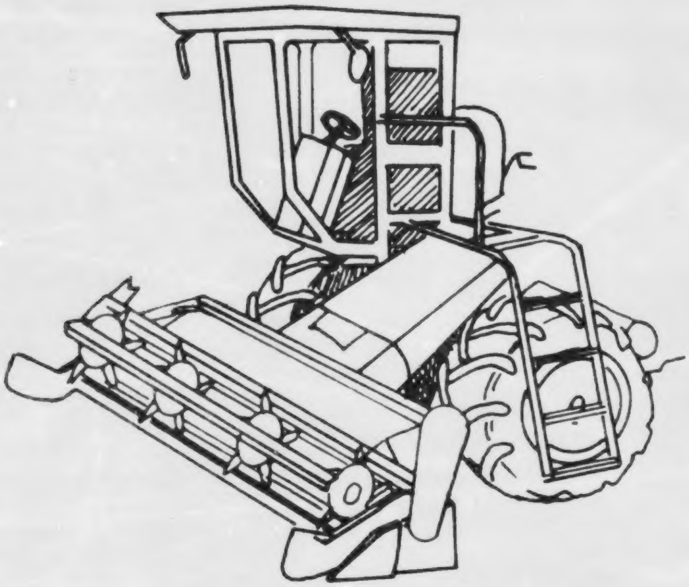
**COMBINE
"OPERATOR"**

GRAIN HARVESTING UNIT

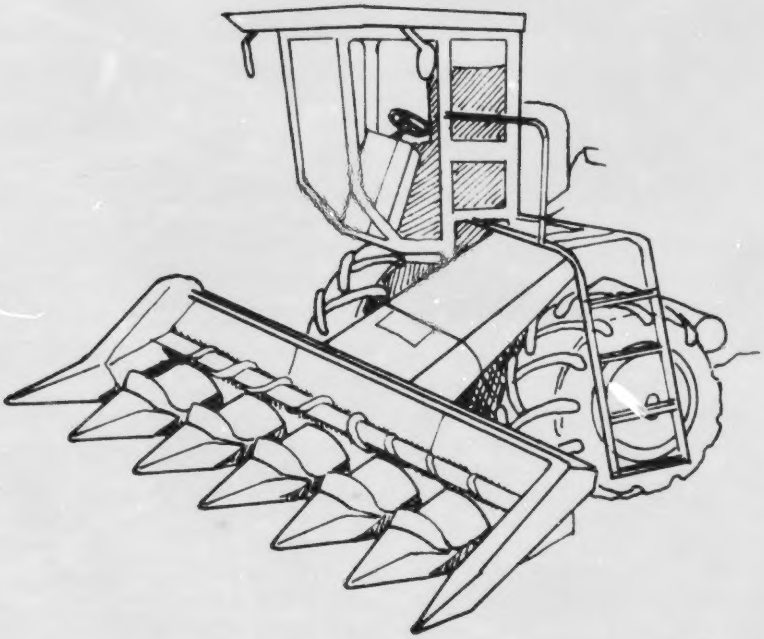

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

II-E-2-35

COMBINE HEADERS

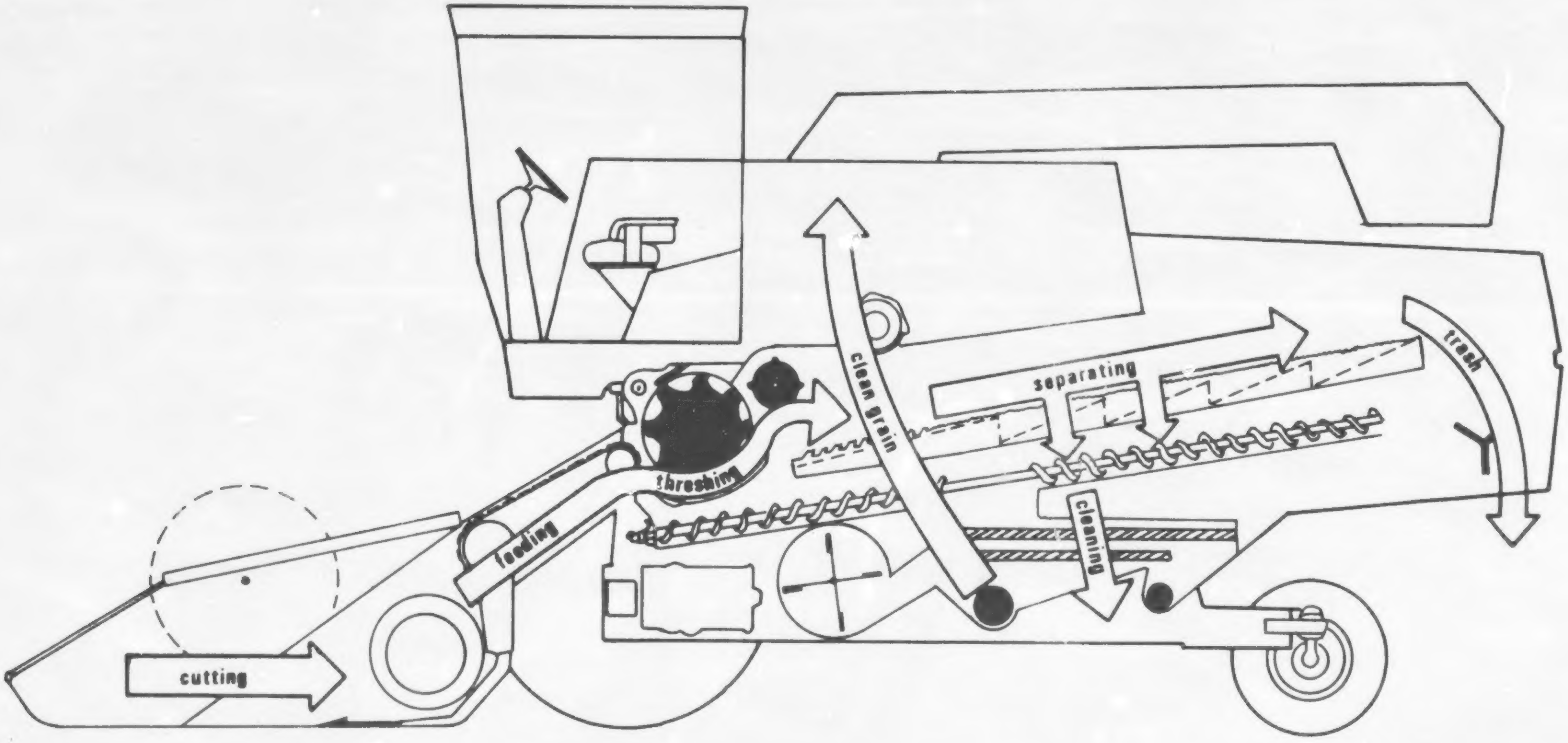


Grain head

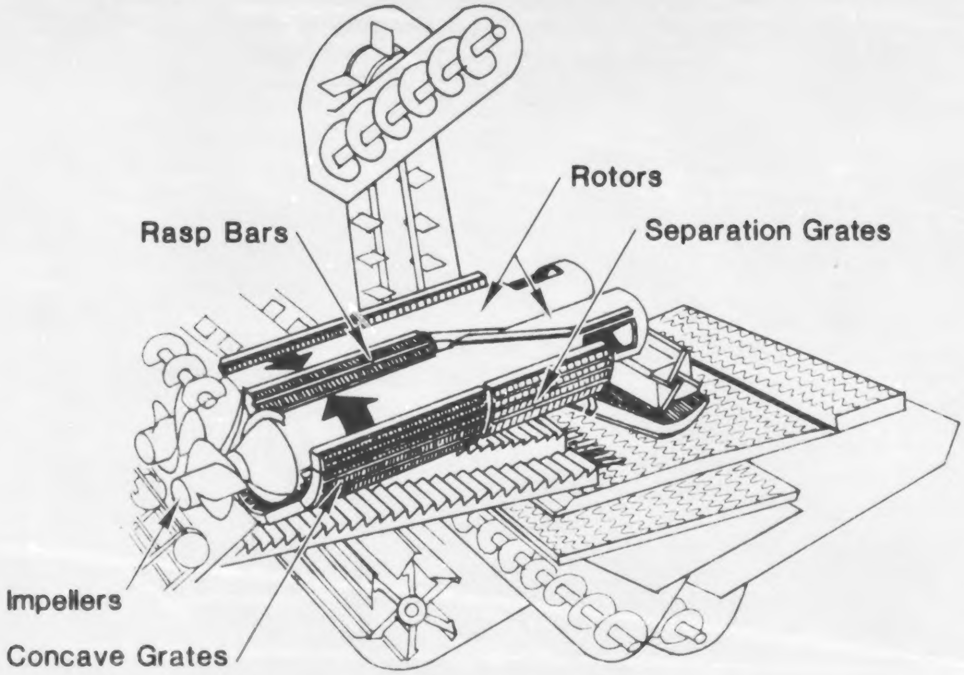


Corn head

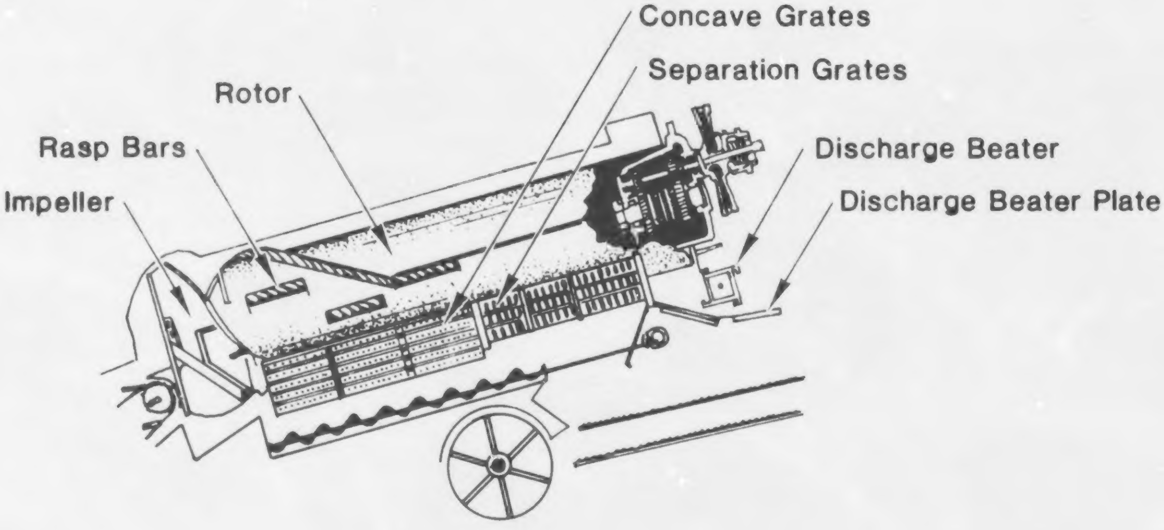
HOW GRAIN FLOWS THROUGH A COMBINE


cutting
feeding
threshing
clean grain
separating
cleaning
trash

ROTOR TYPE THRESHING UNITS

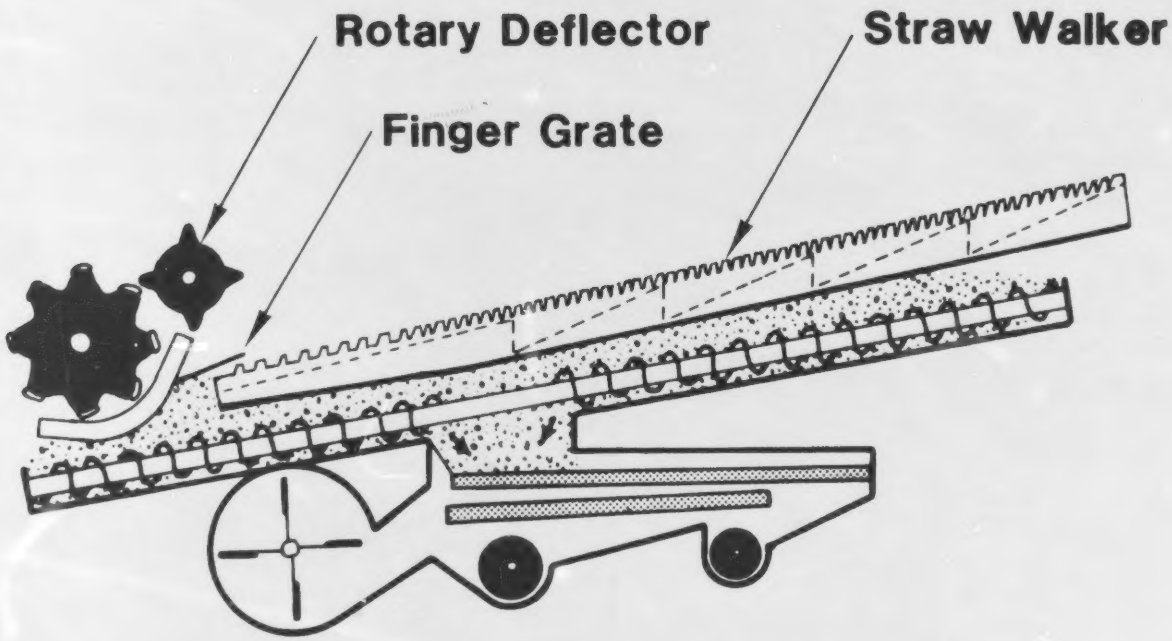

Rotors
Rasp Bars
Separation Grates
Impellers
Concave Grates

Twin Axial Flow Design

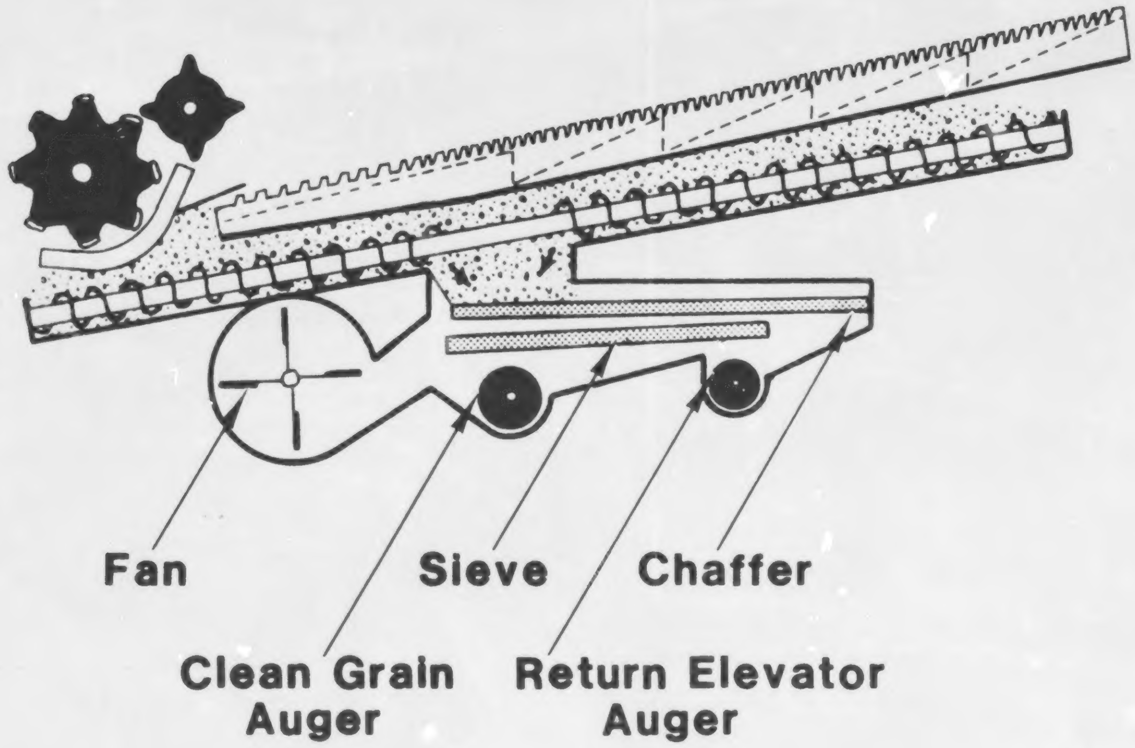

Concave Grates
Separation Grates
Rotor
Rasp Bars
Discharge Beater
Impeller
Discharge Beater Plate

Single Rotor Design

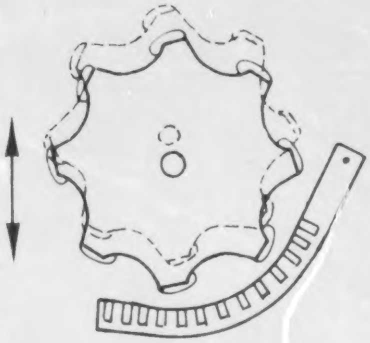
TYPICAL SEPARATING UNITS


Rotary Deflector
Straw Walker
Finger Grate

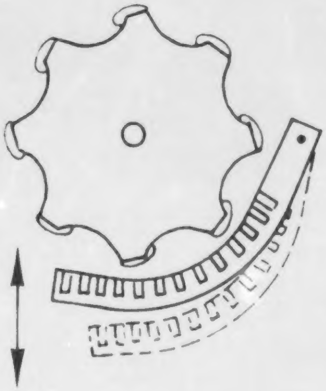
TYPICAL CLEANING UNITS


Fan
Sieve
Chaffer
Clean Grain Auger
Return Elevator Auger

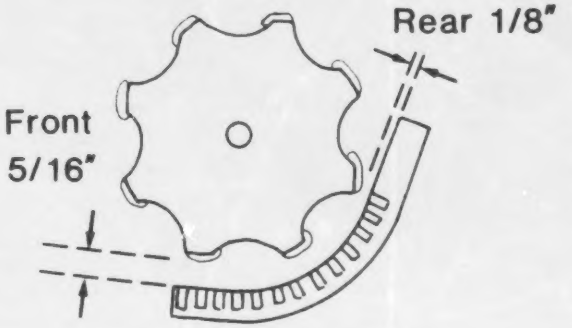
ADJUSTING THRESHING UNITS



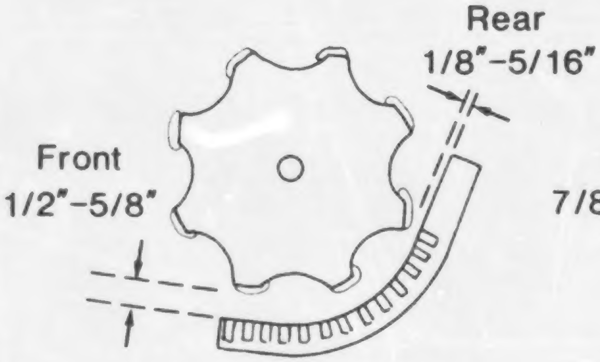
Cylinder Type Adjustment



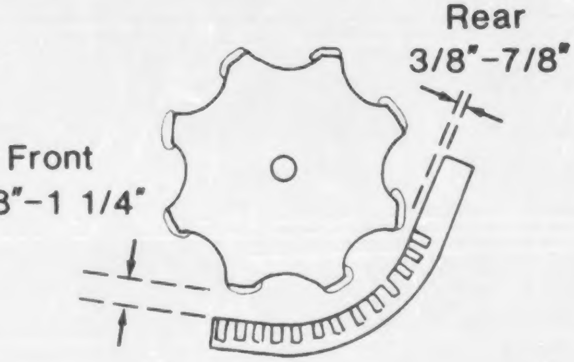
Concave Type Adjustment


Rear 1/8"
Front 5/16"

Small Grain

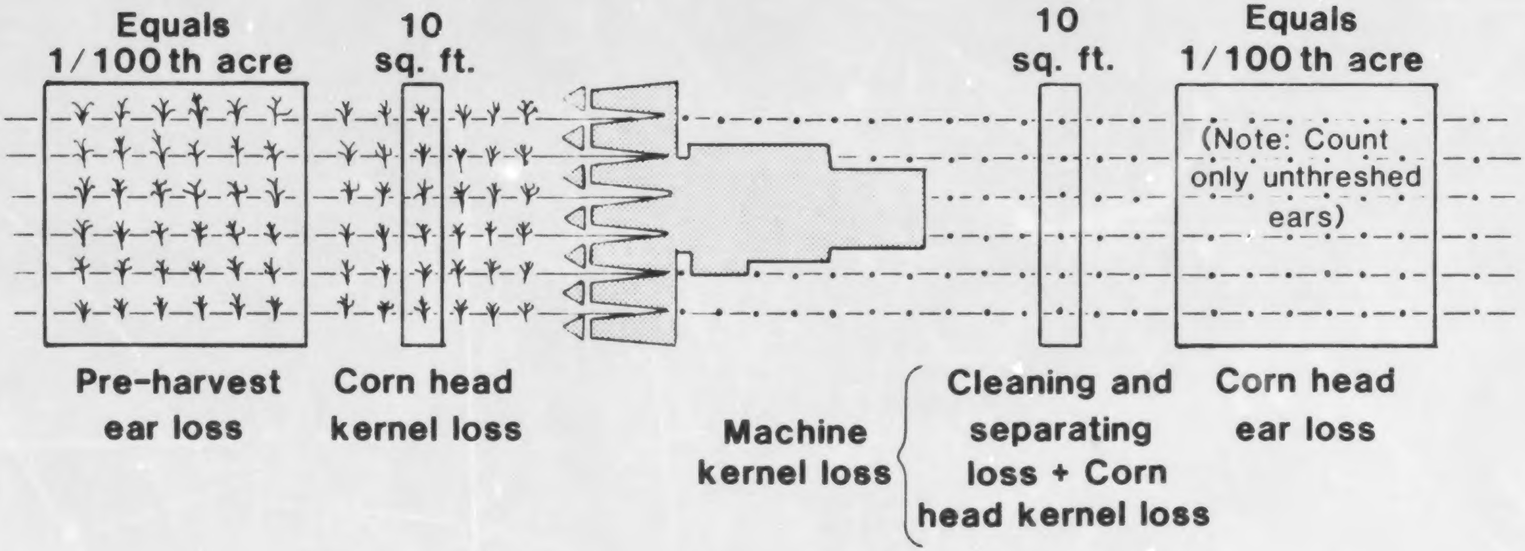

Rear 1/8"-5/16"
Front 1/2"-5/8"

Soybeans


Rear 3/8"-7/8"
Front 7/8"-1 1/4"

Corn

MEASURING CORN LOSSES



Equals 1/100th acre

10 sq. ft.

10 sq. ft.

Equals 1/100th acre

(Note: Count only unthreshed ears)

Pre-harvest ear loss

Corn head kernel loss

Machine kernel loss

Cleaning and separating loss + Corn head kernel loss

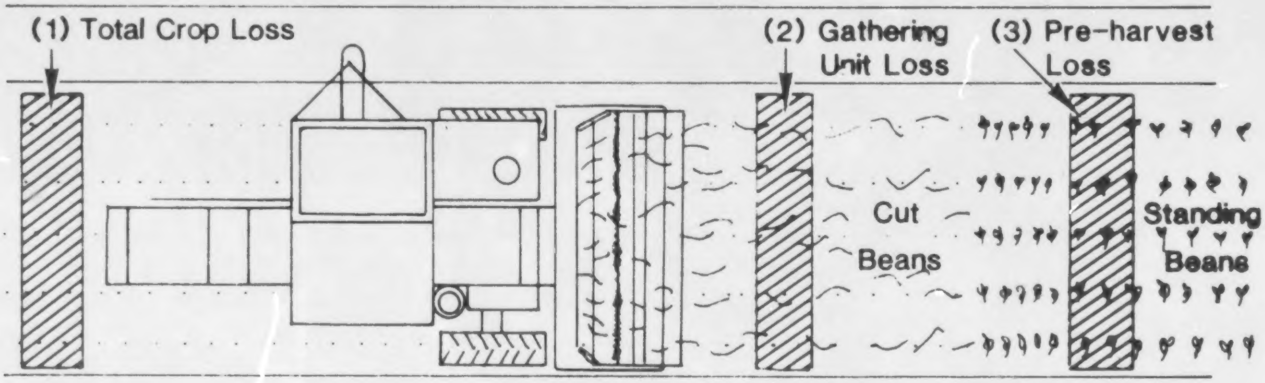
Corn head ear loss

Machine kernel loss - Corn head kernal loss = Cleaning and separating loss

Cylinder loss = Kernels on partially shelled cobs

Machine kernel loss - Corn head loss = Total machine loss

CALCULATING SOYBEAN LOSSES


(1) Total Crop Loss
(2) Gathering Unit Loss
(3) Pre-harvest Loss
Cut Beans
Standing Beans

LOSS DATA WORKSHEET

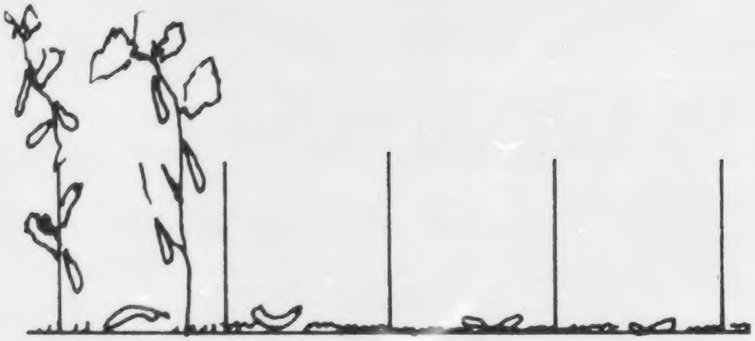
Source of Loss	Column A Beans Found in 10 sq. ft. area	Number of Beans = to 1 bu./acre	Column B Your Bean Loss in bu./acre	Column C Acceptable Loss Level in 40 bu./ acre yield
1. Total Crop Loss		40		1.3
2. Pre-Harvest Loss		40		0.1
3. Machine Loss		40		1.2
4. Gathering Unit Loss		40		1.1
Totals of: a. Shatter		40		0.4
b. Loose Stalk		40		0.2
c. Lodged Stalk		40		0.2
d. Stubble		40		0.3
5. Cylinder and Separation Loss				0.1

II-E-2-43

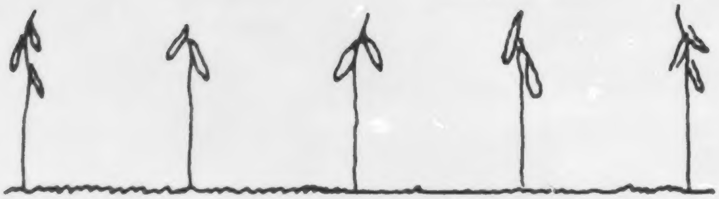
KEEP COMBINE LOSSES LOW

1. Properly adjust parts.
2. Level seedbed.
3. Cutterbar close to ground.
4. Ground speed low.
5. Proper reel speed.

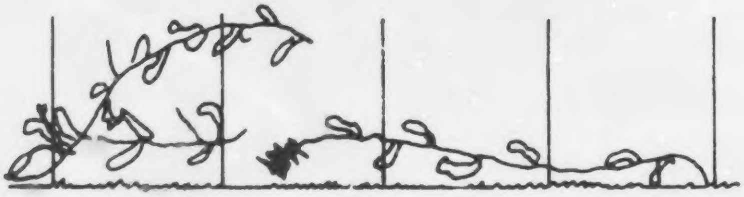
TYPES OF SOYBEAN LOSSES



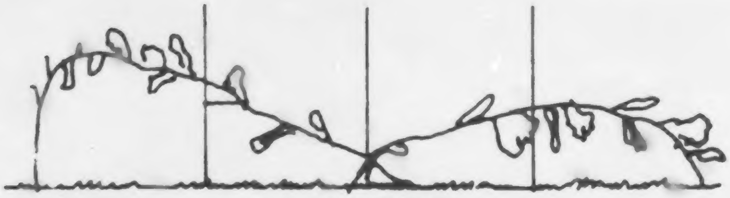
SHATTER



STUBBLE



STALK



LODGED

TRANSPARENCY DISCUSSION GUIDE

HARVESTING FARM CROPS

I. Transparencies--COMBINE DRIVER-OPERATOR and DIFFERENCES BETWEEN DRIVER and OPERATOR

  A. Introduce the basics of combine operation by emphasizing the difference between being a combine driver and combine operator.

  B. Ask students to identify what they need to know about a combine to be a good operator.

  C. Lead discussion toward checking and adjusting various parts of the combine.

II. Transparency--GRAIN HARVESTING UNIT

  A. Point out importance of knowing the names and locations of various parts of the combine.

  B. Use this transparency with Worksheet 1 as an aid in helping students understand the functions of a combine.

  C. Briefly explain the major function of each of the 16 parts identified on the transparency.

    1. Reel--holds grain against cutterbar then sweeps cut grain onto platform.

    2. Cutterbar--cuts stems of plants.

    3. Auger--(platform auger) collects and moves grain to feeder conveyor system.

    4. Feeder conveyor--moves cut grain from platform to threshing cylinder system.

    5. Concave--series of curves steel bars located under and slightly to the rear of the cylinder. Responsible for about 90% of the threshing.

    6. Threshing cylinder--rotating cylinder which rubs grain against concave. The most common design uses raspbars on the cylinder.

    7. Rotary deflector--also called "beater" located above and behind cylinder. It does two things:

    a. slows down material
    b. directs materials down onto straw walkers

8. Finger grate--located at rear of concave. Holds material against rotary deflector.

9. Cleaning fan--creates air movement to separate chaff and straw from grain.

10. Straw walker--tumbles and shakes straw to separate loose grain, straw, and chaff. The walkers move the straw to the rear of the machine.

11. Chaffer--hold grain and chaff so air from cleaning fan can separate them.

12. Lower clean grain auger--delivers clean grain to clean grain elevator to be deposited into grain tank.

13. Sieve--similar to chaffer, does final cleaning of grain.

14. Lower tailings auger--unclean or unseparated grain is moved back to the cylinder for rethreshing.

15. Tailings chopper--chops and scatters straw and chaff.

16. Grain auger--extend length of the threshing and separating units. Moves grain and chaff from straw walkers to clean grain area of chaffer.

III. Transparency--COMBINE HEADERS

A. Outline the similar features of each header--

1. cutting grain
2. collecting cut grain
3. moving grain to threshing system

B. Identify common crops the headers can be used with.

IV. Transparency--HOW GRAIN FLOWS THROUGH A COMBINE

A. Point out and discuss major functions all combines perform.

B. Develop an outline depicting the functions and each major part of the combine involved in each.

VII. Transparency-- ROTOR TYPE THRESHING UNITS

A. Point out that some combines use a single rotor and some use twin rotors.

B. Explain that most rotors are mounted long-ways in the combine; however, some rotors are mounted cross-ways similar to the cylinder type combine.

C. With rotor-type threshing combines, the grain is in contact with the concave for a longer time.

D. Clearance is adjusted by moving the concaves.

E. Discuss the fact that regardless of the type of threshing unit used. The speed of rasp bar travel of feet per minute does not change. The same crop and conditions require the same amount of rasp bar impact.

V. Transparencies-- TYPICAL SEPARATING UNITS
TYPICAL CLEANING UNITS

A. Discuss specific actions and adjustments of each identified part.

B. Explain the flow of grain through the combine. Promote student discussion on their experiences with combine adjustments and problems.

C. Have students describe the specific function of each part.

VI. Transparency--ADJUSTING THRESHING UNITS

A. Discuss how to properly check for concave clearance.

B. Have students check owners manuals for the methods of concave adjustments.

C. Identify actual settings for specific machines using operators manuals.

VIII. Transparencies--MEASURING CORN LOSSES CALCULATING SOYBEAN LOSSES

A. Use these transparencies to help explain the techniques of measuring grain losses.

B. Explain and discuss the importance of determining grain losses and minimizing them.

IX. Transparencies--TYPES OF SOYBEAN LOSSES, and KEEP COMBINE LOSSES LOW

A. Discuss the major types of losses and how each can be reduced.

B. Have students identify, from their own experiences, the type of loss which is most common and let them suggest ways to counter the problem.

C. Use transparency to outline possible ways to reduce combine losses.

TEACHER'S KEY

SAMPLE TEST QUESTIONS

HARVESTING FARM CROPS

T or F

1. F The self propelled combine was developed in the 1890's.

2. T The purpose of the fan is to blow out chaff, dirt, and small particles away from the crop.

3. T All combines use some type of cylinder to thresh the crop.

4. F The bars around the threshing cylinder are called hasp bars.

5. F A floating cutter bar is only used on hillside combines.

Multiple Choice

A 6. The part that carries the corn ear up to the head auger or cross auger is called the:
- a. gathering chains
- b. snapping rollers
- c. gatherer points
- d. feeder conveyor

D 7. Which of these parts knocks down the straw coming from the threshing cylinder?
- a. cleaning shoe
- b. cutterbar
- c. reel
- d. rotary deflector

D 8. Which of the below items is not an adjustment to the threshing cylinder or concaves?
- a. speed
- b. grate openings
- c. distance between concaves and cylinders
- d. automatic raspbar adjustment

D 9. Which area is checked to determine how well the cylinder is threshing the grain?
- a. grain tank
- b. tailings
- c. behind combine
- d. all of the above

_C_ 10. The most important part of any combine is the:
  a. cylinder
  b. grain tank
  c. operator
  d. return auger

Define the function of each part.

11. cutterbar

12. reel

13. auger (cross auger in head)

14. gathering chains

15. snapping rollers

16. feeder conveyor

17. threshing cylinder

18. chaffer

19. sieve

20. straw walkers

21. Combines perform five basic harvesting functions. These five areas are:

cutting & feeding
threshing
separating
cleaning
handling

22. Using the worksheets as guides, develop harvesting loss problems for corn, soybeans, and small grains.

23. Correctly match the parts of the combine on transparency "Grain Harvesting Unit" to the correct name:

31	Auger (platform)
11	Chaffer
9	Cleaning fan
5	Concave
2	Cutterbar
4	Feeder conveyor
8	Finger grate
16	Grain auger
12	Lower clean grain auger
14	Lower tailings auger
1	Reel
7	Rotary deflector
13	Sieve
15	Tailing chopper
10	Straw walker
6	Threshing cylinder

UNIT F: Soil Science and Conservation of Natural Resources

PROBLEM AREAS:

1. Understanding soils
2. Judging land-use capability
3. Buying and using fertilizers

UNIT F: SOIL SCIENCE AND CONSERVATION OF NATURAL RESOURCES

PROBLEM AREA: UNDERSTANDING SOILS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade or second year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is during the early fall or late spring. The estimated time for teaching this problem area is 3 to 5 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions;

1. Student's have already received related instruction in soil through Core I materials.
2. Students will have an opportunity to observe a soil profile and perform a land-use evaluation project.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts this problem area to his/her local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-22-32-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they construed, as policy or opinion of the Illinois State Board of Education or its staff.

The teacher's guide, worksheets, job sheets, and sample test questions were developed by Chris Mower and Jerry Pepple, Department of Vocational and Technical Education, University of Illinois. The transparency masters were prepared by Vocational Agriculture Service, University of Illinois.

Suggestions and guidance in the development of these materials were provided by Paul Hemp, Project Director and by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Soils and conservation of natural resources

II. Problem area: Understanding soils

III. Objectives: At the end of this problem area, the student will be able to:

1. Define soil.

2. Identify physical properties of the soil, including color, structure, texture.

3. Determine soil class and associated limitations.

4. Recommend management practices for different soils.

IV. Suggested interest approaches:

1. Discuss local soil types or have students name as many local soil types as they can. Keep a list on the board.

2. Ask students why they need to know about soil types.

3. Ask if anyone has every seen an exposed soil profile, like the side of a basement at a construction site, or along a ditch bank.

4. Ask the lead questions:

   a. "Why do dark soils yield more than light soils?"
   b. "What is erosion?"
   c. "Why do we say some soils are 'old' and some are 'young'?"
   d. "What soil types are on your own farm?"
   e. "What do we need to know about soil to mange it well?"

V. Anticipated problems and concerns of students:

1. What is soil?

2. What is soil profile?

3. How were soils formed?

4. What can i tell from the color of the soil?

5. What is soil texture and how do you determine it?

6. What are the common soil structures?

7. Why do some soils drain or dry faster than others?

8. How do I figure slope?

9. What is soil position?

10. What are land classes?

VI. Suggested learning activities and experiences:

1. Have class identify their problems and concerns and record them on a chalkboard.

2. Distribute reference materials to students and discuss tentative answers to problems and concerns.

3. Have students complete Worksheet #1, using VAS 4052 as a reference.

4. Demonstrate ribbon test and have students practice and complete Job Sheet #1.

5. Plan various field trips. Suggestions for possible field trips are:

    a. To examine soil profile, color structure and texture at a basement construction site or pit dug for that purpose.

    b. To ASCS conservation project.

    c. To where land tile is being installed.

6. Use surveying equipment to determine slope (Survey kits available from VAS). Let students practice laying out contours and calculating percent slope.

7. Develop a soil map of selected home farms and discuss findings. Include soil type, class, and suggested management practices.

8. Show and discuss VAS Soil Science Transparencies. Selected transparency masters and discussions are included in this problem area.

9. Use a resource speaker such as a representative from the Soil Conservation Service or Extension Office. Possible topics include "use of drainage tile," "conservation structures," "using the soil loss equation," etc.

10. Explain the parts of the soil judging score cards and how each section is used to determine soil types.

11. Conduct a chapter land use selection contest.

12. Participate in section land use selection contest.

13. View slide film on Soil Color (VAS #708) and complete Student Worksheet #2.

VII. Application procedures:

1. The purpose of this problem area is to identify some causes of soil limitations and develop proper management practices.
2. This knowledge and understanding should be applied to developing management and approved practices in the students' S.O.E. projects.

VIII. Evaluation of student progress:

1. Evaluate and grade work of students.
2. Administer test.
3. Grade performance in land use selection contest.

IX. References and aids:

1. Subject matter units from Vocational Agriculture Service:
   a. VAS 4028 Soil Structure
   b. VAS 4029 Soil Color
   c. VAS 4030 Soil Texture
   d. VAS 4052 Understanding Soils
   e. VAS 4053 Using the Illinois Soil Judging Scorecard
2. VAS Soil Science transparencies (a complete set can be obtained from VAS)
3. VAS Slidefilm 708 "Soil Color"

SOILS WORKSHEET #1

SOIL FORMATION

1. What is soil?

2. What is soil made up of?

3. Soils are composed of one or more layers or ______________.

4. Most soils have ________ principal horizons, which are designated by capital letters: the ________ or A horizon, the subsoil or _________ horizon, and the ___________ underlying the subsoil or ________ horizon.

5. Parent materials

glacial origin

a. finely ground rock, "glacial flour" distributed by wind. ______________

b. glaciers carried large amounts of rocky material, grinding much of it into a mixture of gravel, sand, silt and clay. ___________________ ___________________

c. deposited during mild periods by glacial runoff water, deposited in layers. __________________

water deposited

a. sediments in floodplains. ___________________

6. Topography refers to ____________________________________.

7. Soils on steep topography are likely to be subject to severe _________.

8. Native vegetation determines the ___________ and ___________ of organic matter in the soil.

9. Under forest cover, the organic matter is in the form of _______. Since the material is on the surface, it decays _____________ and leaves only a small residue. Total organic matter, therefore, is quite _______.

10. Most prairie soils have a _________ surface layer that is fairly ______. Wild prairie grasses and other plants have abundant _______ which filled the top of the soil 1 or 2 feet down. Partial decay of these roots over a long period of time gave us the high ______________ content of prairie soils, and along with it, the _____________ color.

11. Soils at different stages in the ________________ process will differ widely.

12. Many soils are now ________ because the calcium originally in them has been ____________ away.

13. When the soil is young, ______________________ accumulates, but as soils get older, organic matter and production decline, and clay accumulates in the ______________.

14. Weathering depends on ______________.

15. As a rule, the surface of the soil is darker than the subsoil because it contains more __________________.

16. The darker the surface soil, the ______________ the organic matter.

17. Subsoil colors of Illinois soils are due to the status of __________ compounds. Well drained soils have ___________ colored subsoils because the iron compounds are __________. Soils with poor natural drainage have dull gray or olive gray subsoils because the iron has been ___________.

Texture problems

To what textural class do the following soils belong?

18. 40% sand, 40% silt, 20% clay ______________________

19. 20% sand 60% silt, 20% clay ______________________

20. 50% sand, 10% silt, 40% clay ______________________

21. If you can form a long, pliable ribbon, the soil is ________ textured.

22. If a ribbon forms, but breaks into pieces, 3/4 inch to 1 inch long, the soil is ______________________ textured.

23. Define structure as it relates to soils.

24. Structure does not change soil ____________, but a desirable structure may greatly improve ____________ and the ease with which ________ and _____________ can move through the soil.

25. Try to draw a picture of each of the 6 main kinds of structures.

granular	angular blocky	prismatic
____________________	____________________	____________________
platy	subangular blocky	columnar
____________________	____________________	____________________

26. The moisture holding capacity of a soil is closely related to its __________. As the clay content increases, there are ________ soil particles to hold water. So a soil high in clay holds ___________ water than a sandy soil.

27. While moisture holding capacity is important, too much water will crowd the _______ out of the soil. If water moves freely through the profile, air can fill the empty _____ spaces. When water moves too fast, however, the result is a _________ soil.

28. Water drains very slowly from the small __________; therefore, fine textured soils have __________ permeability unless the structures of the surface and subsoil permits water to pass through.

29. If crops are to produce heavily, they must have a _________ system so that they can get nutrients and water from a large volume of ______. Coarse _________ and _________ discourage root growth because they have little ___________ or plant nutrients.

30. Slope of the land influences the _____ with which water runs off a field and the amount of _______ that washes off with the water. Usually slope is expressed in _______ or feet of fall in each 100 feet of horizontal distance.

    Problem: The soil drops 6 inches in 25 ft. of horizontal distance.
    Calculate the percent slope. __________

31. The __________ is the most valuable part of the soil profile since it contains more ___________ and organic matter, and can often absorb more moisture than the other layers.

32. The principal loss of soil is usually by _________ erosion.

33. In assigning soils to various classes, soil scientists are concerned with 3 questions. What are they?

LAND CLASS CHART

Class	Map Color	Limitations	Conservation practices or Possible Uses
I			
II			
III			
IV			
V			
VI			
VII			
VIII			

WORKSHEET #2

SOIL COLOR

1. What gives the surface soil its dark color?

2. What caused the thick, dark surface layer in prairie soils?

3. Why is the surface layer thinner on timber soils?

4. Why are the prairie soils of Southern Illinois lighter than those of northern Illinois?

5. Why is erosion more hazardous on timber soils than on prairie soils?

6. What other than organic matter influences subsoil colors?

7. Why do soils that are poorly drained tend to be dull colored?

8. What colors are found in subsoils that are wet part of the time?

9. What names are used to describe surface soil colors? Subsoil colors?

JOB SHEET #1

DEMONSTRATING RIBBON TEST FOR SOIL TEXTURE

Objective: To learn how to determine soil texture in the field.

Materials:

1. Soil samples of various textural groups (fine, moderately fine, medium, etc.)
2. Water for moistening samples, if needed.

Procedures:

1. Moisten a sample of soil to the consistency of a workable putty.
2. From this sample, make a ball about ½ inch in diameter.
3. Hold the ball between the thumb and forefinger, and gradually press the thumb foreward, forming the soil into a ribbon.
4. If a ribbon forms easily, and is long and pliable, the soil is fine-textured.
5. If a ribbon forms but breaks into pieces 3/4 to 1 inch long, the soil is moderately fine-textured.
6. If no ribbon is formed, and soil feels smooth and talc-like with little grittiness, the soil is medium textured.
7. If no ribbon is formed, and the soil fees very gritty, the soil is moderately coarse textured.
8. If sample consists almost entirely of gritty material and leaves little or no stain on the hand, it is coarse textured.

Exercise:

1. Have students practice the procedure.
2. Have students identify the textural group of each of the various soil samples.

Questions:

1. Which sample formed the longest ribbon?______________
2. Which sample had the highest clay content?___________
3. Which sample felt grittiest?__________________________
4. What is the textured class of that sample?_____________
5. Why should soil be moist to do this test?______________
____

TEACHER'S KEY

SOILS WORKSHEET #1 (REFERENCE VAS UNIT 4052)

SOIL FORMATION

1. What is soil? (See VAS unit 4052, part 1)

2. What is soil made up of? mineral matter, organic matter, water and air.

3. Soils are composed of one or more layers or horizons.

4. Most soils have three principal horizons, which are designated by capital letters: the surface or A horizon, the subsoil or B horizon, and the substratum underlying the subsoil or C horizon.

5. Parent materials

   glacial origin

   a. finely ground rock, "glacial flour" distributed by wind. loess
   b. glaciers carried large amounts of rocky material, grinding much of it into a mixture of gravel, sand, silt and clay. glacial till
   c. deposited during mild periods by glacial runoff water, deposited in layers. outwash

   water deposited

   a. sediments in floodplains. alluvium

6. Topography refers to slope characteristics of a soil.

7. Soils on steep topography are likely to be subject to severe erosion.

8. Native vegetation determines the kind and amount of organic matter in the soil.

9. Under forest cover, the organic matter is in the form of duff. Since the material is on the surface, it decays rapidly and leaves only a small residue. Total organic matter, therefore, is quite low.

10. Most prairie soils have a dark surface layer that is fairly deep. Wild prairie grasses and other plants have abundant roots which filled the top of the soil 1 or 2 feet down. Partial decay of these roots over a long period of time gave us the high organic matter content of prairie soils, and along with it, the black color.

11. Soils at different stages in the weathering process will differ widely.

12. Many soils are now acid because the calcium originally in them has been leached away.

13. When the soil is young, organic matter accumulates, but as soils get older, organic matter and production decline, and clay accumulates in the B horizon.

14. Weathering depends on climate.

15. As a rule, the surface of the soil is darker than the subsoil because it contains more organic matter.

16. The darker the surface soil, the higher the organic matter.

17. Subsoil colors of Illinois soils are due to the status of iron compounds. Well drained soils have bright colored subsoils because the iron compounds are oxidized. Soils with the poor natural drainage have dull gray or olive gray subsoils because the iron has been reduced.

Texture problems

To what textural class do the following soils belong?

18. 40% and, 40% silt, 20% clay loam

19. 20% sand, 60% silt, 20% clay silt loam

20. 50% sand, 10% silt, 40% clay sandy clay

21. If you can form a long, pliable ribbon, the soil is fine textured.

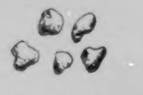
22. If a ribbon forms, but breaks into pieces, 3/4 inch to 1 inch long, the soil is moderately fine textured.

23. Define structure as it relates to soils.
(refer to VAS unit 4052 - pp. 12 and 13.)

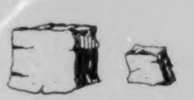
24. Structure does not change soil texture, but a desirable structure may greatly improve tilth and the ease with which air and water can move through the soil.

25. Try to draw a picture of each of the 6 main kinds of structures.
(Refer to VAS 4052 - p. 14)

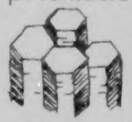
granular



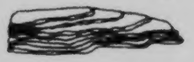
angular blocky



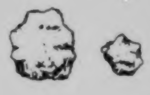
prismatic



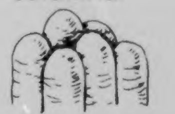
platy



subangular blocky



columnar



26. The moisture holding capacity of a soil is closely related to its texture. As the clay content increases, there are more soil particles to hold water. So a soil high in clay holds much more water than a sandy soil.

27. While moisture holding capacity is important, too much water will crowd the air out of the soil. If water moves freely through the profile, air can fill the empty pore spaces. When water moves too fast, however, the result is a drouthy soil.

28. Water drains very slowly from the small pores; therefore, fine textured soils have low permeability unless the structures of the surface and subsoil permits water to pass through.

29. If crops are to produce heavily, they must have a large root system so that they can get nutrients and water from a large volume of soil. Coarse sand and gravel discourage root growth because they have little moisture or plant nutrients.

30. Slope of the land influences the speed with which water runs off a field and the amount of soil that washes off with the water. Usually slope is expressed in percent or feet of fall in each 100 feet of horizontal distance.

Problem: The soil drops 6 inches in 25 ft. of horizontal distance. Calculate the percent slope. 2%

31. The top soil is the most valuable part of the soil profile since it contains more nutrients and organic matter, and can often absorb more moisture than the other layers.

32. The principal loss of soil is usually by sheet erosion.

33. In assigning soils to various classes, soil scientists are concerned with 3 questions. What are they?
(refer to top of p. 19, VAS Unit 4052)

TEACHER'S KEY

LAND CLASS CHART

Class	Map Color	Limitations	Conservation practices or Possible Uses
I	Green	(refer to VAS 4052, part 4)	(refer to VAS 4052, part 4)
II	Yellow		
III	Red		
IV	Blue		
V	Uncolored		
VI	Orange		
VII	Brown		
VIII	Purple		

TEACHER'S KEY

WORKSHEET #2

REFERENCE VAS SLIDEFILM 708

SOIL COLOR

1. What gives the surface soil its dark color?
   (refer to frame 9)

2. What caused the thick, dark surface layer in prairie soils?
   (refer to frame 13)

3. Why is the surface layer thinner on timber soils?
   (refer to frame 17)

4. Why are the prairie soils of Southern Illinois lighter than those of northern Illinois.
   (refer to frame 19)

5. Why is erosion more hazardous on timber soils than on prairie soils?
   (refer to frame 21)

6. What influences subsoil colors instead of organic matter?
   (refer to frame 26)

7. Why do soils that are poorly drained tend to be dull colored?
   (refer to frames 28 & 29)

8. What colors are found in subsoils that are wet part of the time?
   (refer to frame 30)

9. What names are used to describe surface soil colors? Subsoil colors?
   (refer to frames 31 and 33)

WHY SOILS ARE IMPORTANT

1. Plants grow in and on soil
2. Plants support animal life
3. Plants and animals support human life
4. World population is rapidly increasing
5. A large part of the world's population has inadequate nutrition
6. World supply of productive soil is limited
7. Improved soil management could feed more people

SOIL ORIGINS

1. Residual

A. Inorganic matter (from minerals and rock)

- a. Igneous
- b. Sedimentary
- c. Metamorphic

B. Organic matter (from plant or animal life)

2. Transported

A. Wind (loess)

B. Water (alluvial)

C. Ice (glacial till)

PHYSICAL BREAKDOWN OF ROCKS

Wind

Plants and animals

Heating and cooling

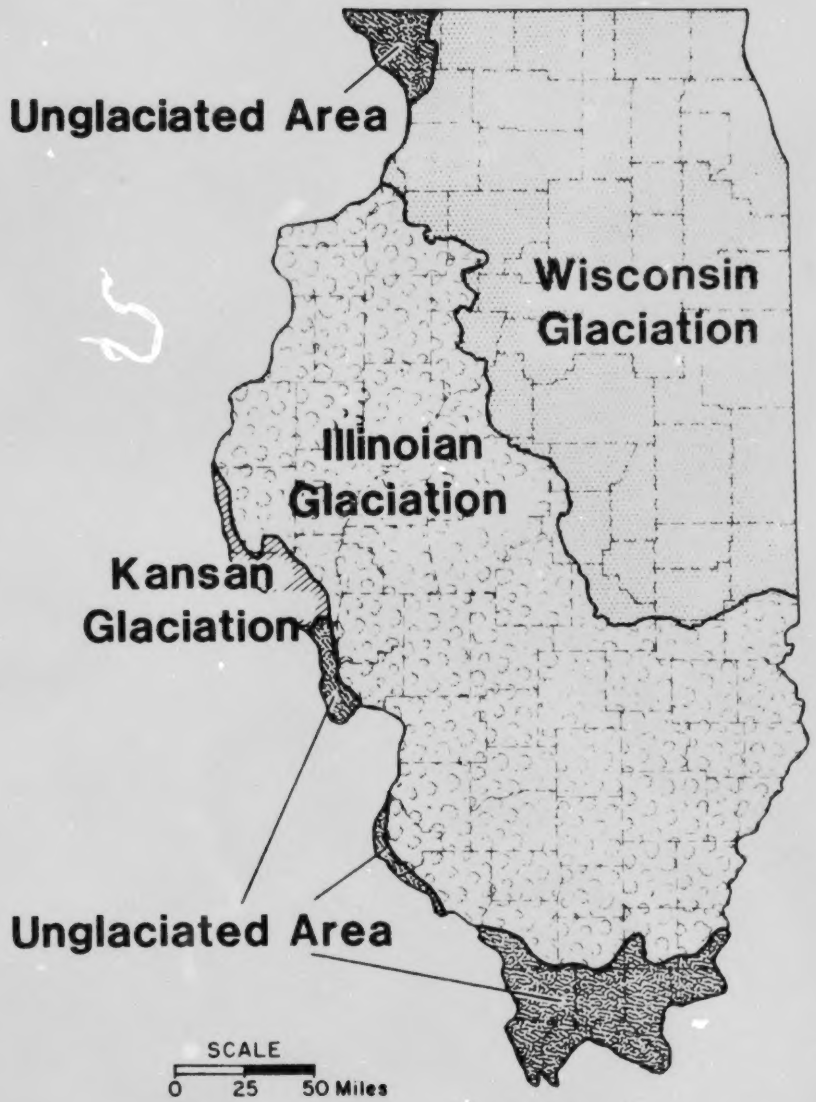
Freezing and thawing

Wetting and drying

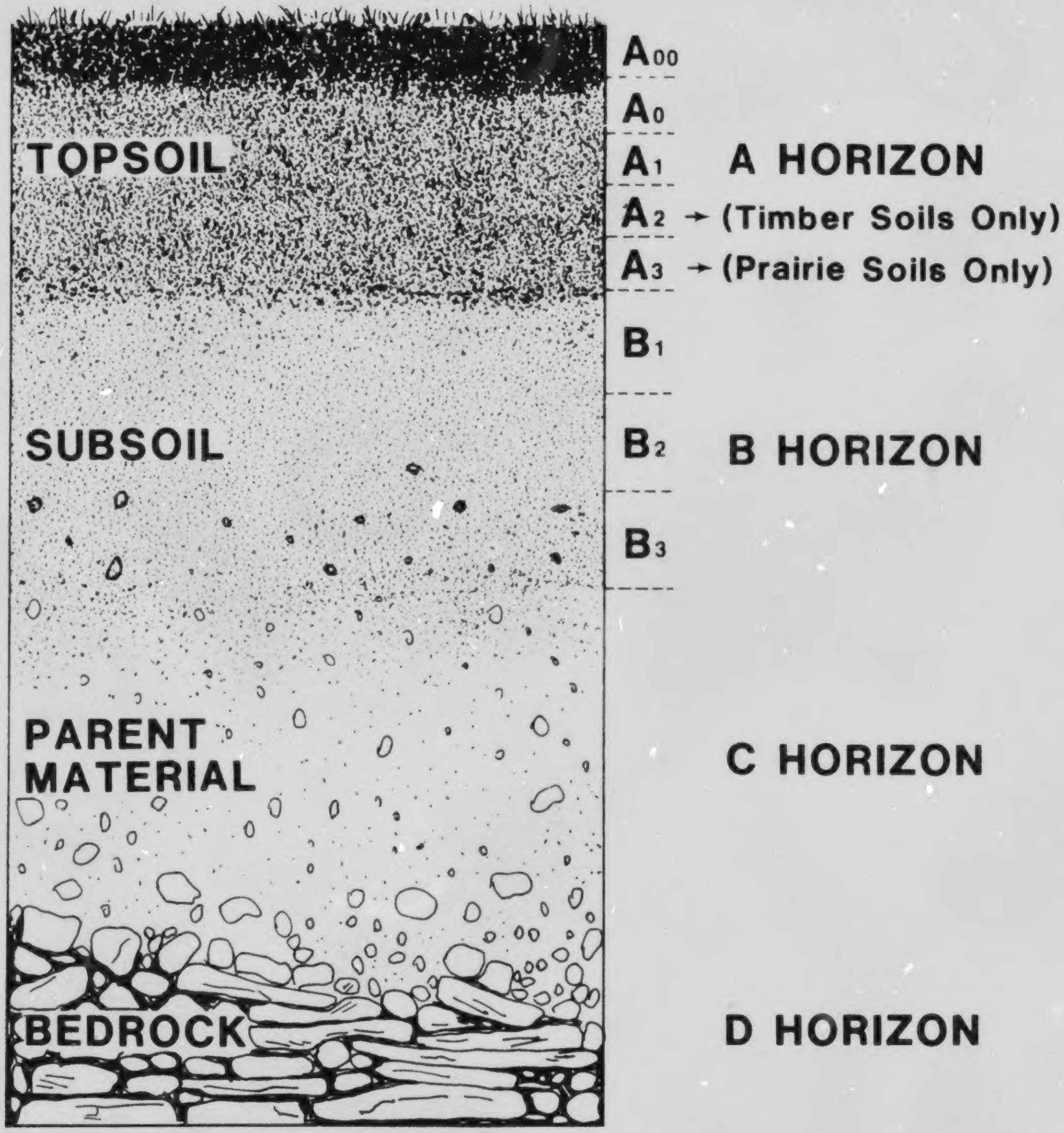
Rivers

(Glaciers and landslides)

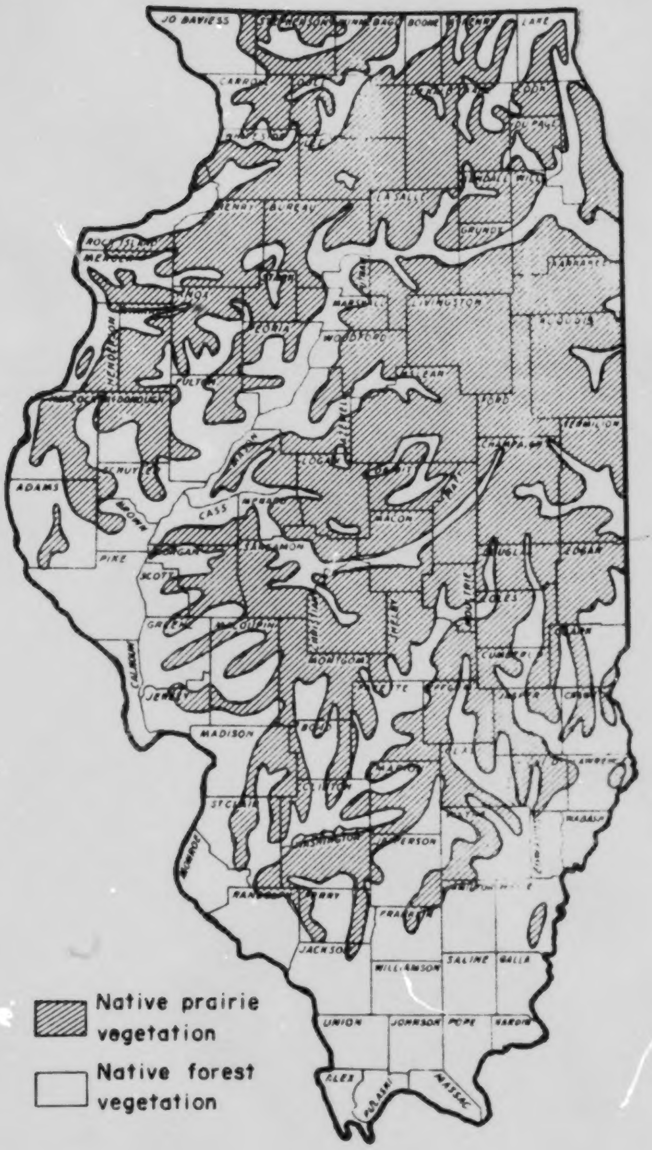
EXTENT OF GLACIATION IN ILLINOIS


Unglaciated Area
Wisconsin Glaciation
Illinoian Glaciation
Kansan Glaciation
Unglaciated Area
SCALE
0
25
50 Miles

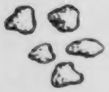
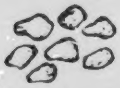
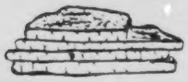
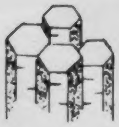
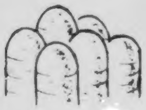
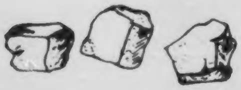
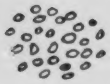
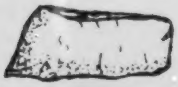
SOIL PROFILE


A00
A0
TOPSOIL
A1
A HORIZON
A2 → (Timber Soils Only)
A3 → (Prairie Soils Only)
B1
SUBSOIL
B2
B HORIZON
B3
PARENT MATERIAL
C HORIZON
BEDROCK
D HORIZON

NATIVE VEGETATION


JO DAVIESS
BOONE
LAKE
CARROLL
LA SALLE
GRUNDY
HENRY
BUREAU
ROCK ISLAND
KANKAKEE
LIVINGSTON
MARSHALL
WOODFORD
PEORIA
FULTON
McDONOUGH
VERMILION
CHAMPAIGN
ADAMS
SCHUYLER
BROWN
CASS
MENARD
LOGAN
MACON
PIKE
SCOTT
MORGAN
SANGAMON
DOUGLAS
EDGAR
GREENE
MACOUPIN
CALHOUN
JERSEY
MONTGOMERY
COLES
MADISON
ST CLAIR
MONROE
WABASH
WASHINGTON
RANDOLPH
PERRY
JACKSON
WILLIAMSON
SALINE
UNION
JOHNSON
POPE
HARDIN
ALEX
PULASKI
MASSAC
Native prairie vegetation
Native forest vegetation

COMMON TYPES OF SOIL STRUCTURE

TYPE	SHAPE
Granular	
Crumb	
Platy	
Prismatic	
Columnar	
Blocky	
Single Grain	
Massive	

CHARACTERISTICS OF THE VARIOUS SOIL CLASSES

Characteristics	Sand	Silt	Clay
LOOSENESS	Good	Fair	Poor
AIR SPACE	Good	Fair to Good	Poor
DRAINAGE	Good	Fair to Good	Poor
TENDENCY TO FORM CLODS	Poor	Fair	Good
EASE OF WORKING	Good	Fair to Good	Poor
MOISTURE HOLDING CAPACITY	Poor	Fair to Good	Good
FERTILITY	Poor	Fair to Good	Fair to Good

TRANSPARENCY DISCUSSION GUIDE

UNDERSTANDING SOILS

I. Transparency--WHY SOILS ARE IMPORTANT

  A. Use this transparency to supplement student's ideas and to promote further class discussion.

  B. Ask students to identify places in the community, state, or world where soil is being abused.

  C. Point out the importance of soil to the Illinois economy.

  D. Point out the fact that Illinois has the best soil in the world for crop production.

II. Transparency--SOIL ORIGINS

  A. Explain why it is necessary to understand the origin of parent material before we can understand and classify soils.

    1. Geological formation is beginning soil material.

    2. Varies in thickness from few feet to several feet.

    3. When parent material gets exposed to the surface elements, soil formation begins.

    4. Productive soils are developed from parent materials which contain an abundant supply of all essential elements which are needed for plant growth. Organic and inorganic materials.

  B. Residual parent material can be organic or inorganic.

  C. Sedimentary rock is the most common inorganic formation for soil parent material. Examples of inorganic residual materials are limestone, sandstone, shales and slates.

  D. Organic--partially decomposed plant or animal material.

  E. Transported materials which are common to Illinois are:

    1. loess--soil materials transported by wind.
    2. alluvial--soil materials transported by flowing water.
    3. glacial till--soil materials transported by ice.

  F. Soil formation is more complicated than just the weathering of rocks. Chemical, physical, and mechanical processes must interact to form the distinguishing soil layers or horizons.

III. Transparency--PHYSICAL BREAKDOWN OF ROCKS

A. Weathering of rock produces soil parent material.

B. Involves physical and chemical processes.

C. This process goes on constantly.

IV. Transparency--EXTENT OF GLACIATION IN ILLINOIS

A. Illinoian and Wisconsin glaciers furnished most of Illinois' soil material.

B. Kansan glacier was the first glacier to cover Illinois.

C. Illinoian glacier was the second glacier to cover Illinois. It covered nearly all the state except the seven southernmost counties.

D. Wisconsin glacier later covered some of the same area but did not advance as far south.

V. Transparency--SOIL PROFILE

A. Vertical section of soil which extends through all the horizons.

B. Soils can be identified and classified by studying the soil profile.

C. Horizons vary in depth and often mix with one another.

D. Major horizons are A-B-C and these are then further divided--

A_{oo} - undecomposed plant and animal material, loose leaves, grass, etc.
A_o - partially decomposed organic matter
A_1 - dark colored high organic matter and mineral matter
A_2 - light colored only found in timber soils
A_3 - changing to B, only found in prairie soils
B_1 - a lot like A_3--sometimes absent
B_2 - high in clay content or iron
B_3 - changing to C--mixed with C

E. Point out that the A and B horizons are the major parts of a soil profile.

F. The C horizon is loose parent material.

G. The D horizon is not parent material but can physically affect the characteristics of the soil above it.

VI. Transparency--NATIVE VEGETATION

A. Two main types which have influenced Illinois soils:

   1. prairie or grass
   2. trees or forest

B. Point out that about 55% of Illinois had prairie soil and about 45% had forest vegetation when Illinois was being settled.

C. Prairie soils are generally dark colored and high in organic matter, unless they are highly weathered and matured as in Southern Illinois.

D. Forest soils are generally light colored and low in organic matter. The A horizon is not very deep.

VII. Transparency--COMMON TYPES OF SOIL STRUCTURE

A. Point out that structure refers to the arrangement of soil particles into various sizes and shapes.

B. Discuss which types of structure are most desirable and which are least desirable.

C. Point out the horizon in which each structure would be found.

VIII. Transparency--CHARACTERISTICS OF VARIOUS SOIL CLASSES

A. Point out the characteristics of each soil particle.

B. Use the soil triangle to discuss how the proper amounts of each particle contribute to the makeup of a desirable soil.

TEACHER'S KEY

SAMPLE TEST QUESTIONS

UNDERSTANDING SOILS

Write "T" for True - "F" for False

T 1. Soil is the outer portion of the earth's crust that supports the growth of plants.

F 2. 90% of the total volume of the soil is made up of mineral and organic matter. The rest is pore space filled with air and water.

F 3. Very few of Illinois' soils have been from material originally moved by glaciers.

T 4. Topography refers to the slope characteristics of a soil.

F 5. Timber soils tend to be higher in organic matter than prairie soils.

T 6. Erosion losses from deep soils are relatively less important than those from shallow soils.

Select the letter of the correct answer.

d 7. Which of the following is a soil parent material composed of finely ground rock distributed by wind.

a. outwash
b. glacial till
c. alluvium
d. loess

c 8. Which of the following soil parent materials is not of glacial origin?

a. outwash
b. glacial till
c. alluvium
d. loess

a 9. A surface soil with a high organic matter content (5%) will be a ____________ color.

a. very dark
b. dark
c. light
d. very light

b 10. A well drained soil would be expected to have a subsoil with a ______________.

a. dark
b. bright
c. dull
d. mottled

a 11. A soil that is mostly clay would be considered ____________.

a. fine-textured
b. medium-textured
c. moderately coarse-textured
d. coarse textured

c 12. When testing a soil's texture, the sample will not form a ribbon, and feels smooth and talc-like. The soil is

a. fine-textured
b. moderately fine textured
c. medium textured
d. moderately course textured

d 13. Which soil structure is most desirable for a surface soil?

a. platy
b. sub-angular blocky
c. single grain
d. granular or crumb

b 14. What is it called when there is no structure, but soil particles cling together in large uniform masses?

a. angular blocky
b. massive
c. prismatic
d. columnar

b 15. What kind of soil has the highest capacity to hold water for use by plants?

a. soils high in clay
b. soils high in silt
c. soils high in sand
d. soils high in gravel

a 16. Course textured soils tend to have ______________.

a. rapid permeability
b. moderate permeability
c. slow permeability
d. textured doesn't affect permeability

d 17. A soil that has 4 feet of silt loam on top of bedrock would be considered __________.

a. very shallow
b. shallow
c. moderately deep
d. deep

c 18. If a soil drops 18" in 50ft., what is the percent slope?

a. 18%
b. 9%
c. 3%
d. 1%

d 19. Which of the following factors are considered in determining land class?

a. permanent soil and land characteristics
b. risk of soil damage
c. limitations that must be placed on land use
d. all of the above

b 20. What is the letter designation for the surface horizon?

a. A_2
b. A
c. B
d. C

Essay

21. Describe some conservation practices which may be needed by Class II land.
(refer to part 4, VAS Unit 4052)

22. Is the soil in this region of Illinois "young" or "old"? Explain your answer.

UNIT F: SOIL SCIENCE AND CONSERVATION OF NATURAL RESOURCES

PROBLEM AREA: JUDGING LAND-USE CAPABILITY

SUGGESTIONS TO THE TEACHER:

The contents for this problem area will be written during the fall of 1982 after the soil judging scorecard format has been finalized.

The estimated teaching time for the problem area is 7 to 10 days. The major objectives for the the problem area are:

1. To understand and complete each section of the Illinois Soil Judging Scorecard.
2. Understand the relationship between Landscape and Soil Profile Characteristics, and the Associated Soil Features-use and management.

This problem area will be delivered during the Fall of 1982 to those who received a copy of Rural Core II. At that time, this page can be discarded and the complete problem area can be inserted in the RAP Core II Notebook.

UNIT F: SOIL SCIENCE AND CONSERVATION OF NATURAL RESOURCES

PROBLEM AREA: BUYING AND USING FERTILIZER

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade or second-year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is during the winter months. The estimated time for teaching this problem area is 7 to 10 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. Students received basic instruction on growing corn and soybeans and soil testing prior to the teaching of this problem area.
2. Students have not received instruction in chemistry.
3. Instructors may wish to divide this problem area into sections which can be taught at different times of the year and/or to different classes.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts this material to his/her local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-32-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed, as policy or opinion of the State Board of Education or its staff.

The teacher's guide, worksheets, transparency discussion guide, job-sheets, and test questions were developed by Jerry Pepple, Department of Vocational and Technical Education, University of Illinois. The transparency masters were prepared by Vocational Agriculture Service, University of Illinois. The student worksheets and sample test questions were developed from materials originally prepared by Brian Cirks, Vocational Agriculture Instructor, Alexis High School and Jerry Kuykendall, Vocational Agriculture Instructor, Maroa-Forsyth High School.

Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Soil science and conservation of natural resources

II. Problem area: Buying and using fertilizers

III. Objectives: At the close of this problem area students will be able to--

1. Identify the common hunger signs of crops.
2. Identify the major plant nutrients and their functions in plants.
3. Identify the secondary and micro-nutrients necessary for plant growth.
4. Determine fertilizer ratios used in commercial fertilizers.
5. Identify the common sources of the major plant nutrients and their methods of application.
6. Calculate the amount of fertilizer to apply in a given situation.

IV. Suggested interest approaches:

1. Bring into class several plants showing nutrient deficiencies or show slides or use the picture sheets contained in VAS Unit 4011a, Hunger Signs in Crops, and develop class discussion on describing the symptoms and cause of the problems.
2. Identify class members with a crop for their S.O.E.P. Have them describe the fertilizer program they are using on the crops.
3. Organize a field trip to a fertilizer dealer. Use Student Worksheet 1, Field Trip Report, and have a representative explain the fertilizer mixes and how he or she determines a proper fertility program. Take small vials and obtain samples of the fertilizer mixes to use later in class for identification and discussion.
4. Invite a local farmer (FFA Alumni or Ag. Advisory council member) to class to explain the process used to plan a fertility program. Possible items to discuss are:
   a. How do you determine the amount to apply?
   b. When do you apply the fertilizer?
   c. What form of fertilizer do you use (dry, liquid, gas)?
   d. What fertilizer ratios do you use?

5. Cut out fertilizer advertisements found in agriculture magazines, pass them around the class, and have students select the brand they would purchase. Identify the specific claims and information contained in the advertisements.

6. Separate the class into small groups. Have them identify the plant nutrients they feel are essential for proper plant growth and the amounts needed per acre. Let each group briefly report their conclusions to the rest of the class.

V. Anticipated problems and concerns of students:

1. What is a fertilizer?
2. What nutrients are in a fertilizer?
3. Where do we get fertilizers?
4. How do plants take up nutrients?
5. What nutrients are required by plants?
6. What are the common signs of nutrient deficiency?
7. What is the meaning of numerals on a fertilizer label?
8. What causes the difference in price?
9. How can we determine what is the best buy for a specific situation?
10. What is a tissue test?
11. Are limestone and gypsum considered fertilizers?
12. Where do plants get their vitamins?
13. Where does fertilizer go that is not used by the plant?
14. What factors determine the rate of fertilization?
15. What are the effects of the primary, secondary and trace elements?
16. What factors determine inorganic fertilizer selection?
17. How do you apply fertilizers?
18. What is a soluble fertilizer?
19. What are slow release fertilizers?
20. What are fast release fertilizers?

21. When should fertilizers be applied?

22. Where can I get information concerning the amount of fertilizer to apply to a crop?

23. What does lime do?

24. What is pH?

VI. Suggested learning activities and experiences:

1. Organize the identified problems and concerns into topic areas, such as:

   a. Major plant nutrients,
   b. Secondary plant nutrients,
   c. Micro nutrients, and
   d. Soil pH.

   Identify tentative answers to the questions and problems through class discussion.

2. Have students identify the common hunger signs in crops. Use Student Worksheet 2, and VAS Unit 4011a, Part 1, What are Some of the Common Hunger Signs of Crops?.

3. Identify the three major plant nutrients. Use Student Worksheet 3, Major Plant Nutrients, and the following VAS units:

   a. 4009b, Planning the Nitrogen Program,
   b. 4008a, Recommending Potassium Fertilizers.

   Also, use the transparencies on the major plant nutrients contained in this problem area and the 1981-82 Illinois Agronomy Handbook, pp 34-47.

4. Use Student Worksheet 4, Secondary and Micro-Plant Nutrients and Soil Liming. Use the Information Sheets on Secondary and Micro-Nutrients and 1981-81 Illinois Agronomy Handbook, pp 47-49.

5. Have students collect various fertilizer tags. Identify the elements, % analysis, and ratios contained in the various fertilizers. Obtain the local current fertilizer price and calculate the cost per pound of nitrogen, phosphorus, and potassium. Relate these costs to selected field cropping systems.

6. Hand out Student Worksheet 5, Determining Fetilizer Rates and Costs. Use current local prices or those used in the example problem. Use VAS Unit 4010a, Part 2 and the 1981-82 Illinois Agronomy Handbook, pp. 35-37, 43-47.

7. Distribute Student Job Sheet 1, and divide the class into small groups and complete the suggested exercises.

8. Administer and evaluate a written test on fertilizer elements and rates of application.

9. Provide students with the opportunity to observe and/or assist in the applying of fertilizer to a field or crop.

10. Develop a fertility program for the school's land laboratory or a student's S.O.E.P.

VIII. Application procedures:

1. The main purposes of this problem area are to teach information and develop attitudes on fertilizers and their use.

2. The application phase should be emphasized in the students' S.O.E. programs, their on-the-job training and the school land laboratories and greenhouses. Accurate fertilization program records should be emphasized.

VIII. Evaluation:

1. Prepare and administer a pencil and paper test using the Sample Test Questions as possible test items.

2. Collect and grade Worksheets 1-5.

3. Evaluate students performance on Job Sheet 1.

4. Evaluate performance of an assigned fertilization project or experiment.

IX. References and aids:

1. The following are available from Vocational Agriculture Service, University of Illinois, Urbana, Illinois.

    a. VAS Unit 4009 b, Planning the Nitrogen Program.

    b. VAS Unit 4008a, Recommending Potassium Fertilizers.

    c. VAS Unit 4006a, Soil Liming--A Key to Better Farming.

    d. VAS Unit 4010a, Planning a Fertilizer Program.

    e. VAS Unit 4011a, Hunger Signs in Crops.

2. 1981-82 Illinois Agronomy Handbook, Circular 1186, College of Agriculture, Cooperative Extension Service, University of Illinois, Urbana, Illinois.

3. Transparencies and discussion guide.

4. Student Worksheets 1-5.

INFORMATION SHEET

SECONDARY NUTRIENTS

Secondary NUTRIENT Action in Soil	Function in Plants	Fertilizer Sources
Calcium (Ca)--Corrects soil acidity. Makes soil more granular for better air and water penetration. Neutralizes by-products of organic matter decomposition. Aids availability of other essential plant nutrients. Soluble calcium minerals are limestone or carbonates of lime.	Stimulates root and leaf development. Helps neutralize and transport organic acids and other compounds of photosynthesis. Its stimulation of vigor and growth increases intake of the other nutrients. Strengthens and thickens cell walls of leaves and stems. Assures plant maturity and high seed production.	Finely ground limestone, quarried and crushed before being ground for application as dry material. For effective results, it should be plowed into the soil profile.
Magnesium (Mg)--Exists in insoluble compounds as magnesium biotites, in slowly soluble forms as dolomitic limestone, and as soluble cations attached to soil colloids. Soils in arid climates may contain large amounts, but excess calcium can reduce Mg intake. In humid areas, plant uptake and leaching deplete soil supplies.	Concentrated in chlorophyll. Also concentrates in seed along with phosphorus. Synthesizes plant materials in chlorophyll. Aids in sugar, oil and fat formation. Has a part in transportation of other plant foods and of synthesized foods to various parts of a plant.	In humid areas, primary fertilizer source is dolomitic limestone. In arid regions, calcium in dolomitic limestone may further tie up Mg. Sources are brucite magnesia, silicate Epsom salts, magnesium nitrate, magensium ammonium, phosphate or magnesium chelates.
Sulphur (S)--Found mostly in organic matter with trace amounts in soil minerals. Released into soil solutions as sulfate. Usually moves through soil with soil solution.	Needed by plants to synthesize amino acids. Essential for protein formation and development. Part of enzyme and vitamin formation. Aids in controlling kind and structure of protoplasm and proteins in plants. Promotes nodule formation in legumes and stimulates seed production. Encourage vigorous plant growth. Helps withstand cold.	Added to soils by rainfall, especially near sulfur-releasing industries. Otherwise, many existing fertilizers contain sulfur--ammonium sulfate, of potash. Often sulfur-containing materials and/or sulfuric acid are added to fertilizers to ensure sufficient nutrient content.

INFORMATION SHEET

MICRONUTRIENTS

Micronutrients Action in Soil	Function in Plants	Fertilizer Sources
Zinc (Zn)--Releasted by decaying crop residues. Mobile and can be leached or eroded. Often deficient in acid sandy soils, alkaline soils with free lime, organic soils with slow residue decomposition. Surface soils have higher content than subsoil. High-phosphate soils also show deficiency.	Essential component of several plant enzymes. Key to formation of many complex organice compounds. Partly regulates intake and efficient water use. Functions associated closely with iron and manganese. Also key element in formation of tryptophane amino acid in corn.	Zinc sulfate is an important carrier and slags have proven almost as effective.
Manganese (Mn)--Exists mostly as oxides and associated with iron and other minerals. Availability controlled by management practices. Dry soils, excessive drainage, high liming rates, low organic matter reduce solubility.	Acts as catalyst. When deficient, plants cannot utilize iron. Specific and essential role in chlorophyll formation. Helps regulate oxidation and reduction processes necessary for forming complex organic compounds in plants.	Manganese sulfate is the base for fertilizers and can be applied to soil or as foliar spray.
Iron (Fe)--Most soils contain ample iron, but often insoluble or unavailable plants. Poorly drained and acid soils usually low in iron.	Acts as catalyst to carry oxygen to leaves for chlorophyll. Transports electrons. During formation of organic complexes, becomes part of compound.	Two basic carriers for fluid fertilizers: ferrous sulfates and chelated forms. Chelating makes iron available for longer time.
Copper (Cu)--Acidic, leached, sandy soils and peat and muck soils usually low or deficient. Tightly bound in organic soils.	Function indirect and complex. Aids root metabolism, oxidation reactions, enzyme production and protein utilization.	Applied as metal, oxide, sulfate, carbonate or chelate. Annual application recommended in small amounts where needed.
Molybdenum (Mo)--Exists largely as impurities in soil minerals and freshly added organic matter. Alkaline soils contain more available Mo than acid soils. Phosphorus and sulfur aid plant absorption.	Concentrated in leaves. Component of enzyme system, helping convert nitrates to ammonia. Aids in fixation of atmospheric nitrogen by legume nodules.	Few ounces per acre usually correct deficiency. Can be mixed with phosphorus containing fertilizer or foliar-sprayed. Sodium molybdate probably most common nutrient carrier.

Micronutrients Action in Soil	Function in Plants	Fertilizer Sources
Boron (B)--Exists in organic matter and many soil minerals. Relatively insoluble in soil minerals, thus much of nutrient comes from organic matter.	Aids utilization of other nutrients, especially calcium, nitrogen, phosphorus. Essential for fruit and seed development. Deficiency stops pollen formation.	Treatments mixed with other fertilizers. Borax is common carrier.
Chlorine (Cl)--Highly soluble in soil and readily leaches in humid areas.	Not well understood, but seems to be associated with movement and efficiency of water.	Little consideration needed, since muriate of potash is used in most fertilizers. Rainfall also deposits about 10 pounds per acre per year.

STUDENT WORKSHEET #1

REPORT ON FIELD TRIP

I. DATE ____________________

II. LOCATION ____

III. FARMER OR BUSINESS VISITED ____________________________

IV. MAIN PURPOSE OF VISIT ____________________________

____

V. IMPORTANT POINTS COVERED

1. ____

____

2. ____

____

3. ____

____

4. ____

____

VI. PRACTICES LEARNED BY TRIP

1. ____

____

2. ____

____

3. ____

____

STUDENT WORKSHEET 2

HUNGER SIGNS IN CROPS

Locate pictures of plants depicting deficiency symptoms, describe the deficiency and the stage of plant growth the symptoms most commonly occur in.

A. Nitrogen Deficiency

Plant(s)	Deficiency Symptoms	Stage of Growth

B. Phosphorus Deficiency

Plants	Deficiency Symptoms	Stages of Growth

C. Potassium Deficiency

Plants	Deficiency Symptoms	Stage of Growth

D. Magnesium Deficiency

Plants	Deficiency Symptom	Stages of Growth

E. Iron and Manganese Deficiency

Plants	Deficiency Symptoms	Stages of Growth

F. Boron Deficiency

Plants	Deficiency Symptoms	Stages of Growth

STUDENT WORKSHEET 3

MAJOR PLANT NUTRIENTS

Part A. Nitrogen

1. Name the three major plant nutrients and the chemical symbol for each.

	Nutrient	Symbol
A.	______________	_____
B.	______________	_____
C.	______________	_____

2. What are the two forms of nitrogen in the soil that plants take up?

A.	______________	_____
B.	______________	_____

3. What do soil bacteria do to soil nitrogen?

4. What are the benefits of providing adequate nitrogen?

5. What is the nutrient content of 150 bu. corn crop?

Elements	Lbs.
N	_____
P_2O_5	_____
K_2O	_____

6. Commercial fertilizers are available in what three forms?

7. What factors should be considered before purchasing fertilizer materials?

8. Name the common carriers of nitrogen and give their percentage of available nitrogen and their form.

Gas

Solid

Liquid

9. Determine the current price per ton of the following nitrogen fertilizers:

		Price	Per Acre Cost of Application
A.	Ammonium nitrate	$	$
B.	Diammonium phosphate (DAP)	$	$
C.	Anhydrous ammonia	$	$
D.	Urea	$	$

Assume you want to apply 150 lbs. of nitrogen to 140 acres of corn. Find the total cost of the amount of nitrogen needed for each of the 4 forms of nitrogen. (Refer to VAS Unit 4009b, page 8, for an example)

10. What are the recommended amounts of nitrogen for:

    A. Corn in a corn-soybean rotation?

    B. Corn in a corn-soybean-wheat rotation?

    C. Corn following clover sod?

    D. Soybeans?

    E. Winter wheat?

    F. Kentucky bluegrass?

11. Why can nitrogen be applied in the fall when the soil temperature drops below 50°F.

12. Identify the advantages and disadvantages of spring and fall applications of nitrogen.

Part B. Phosphorus and Potassium

1. In what form is phosphorus expressed on a fertilizer bag? And how do you convert this to percent phosphorus?

2. In what form is potassium expressed on a fertilizer bag? And how do you convert this to percent potassium?

3. What are the major functions of phosphorus in plants?

4. What are the major functions of potassium in plants?

5. Give the percent of P_2O_5 for the following phosphorus materials.

		% P_2O_5
A.	Super phosphate	______
B.	Triple super phosphate	______
C.	Mono-ammonium phosphate	______
D.	Diammonium phosphate	______
E.	Ammonium polyphosphate	______

6. Give the percent K_2O for the following potassium materials.

		% K_2O
A.	Muriate of potash	______
B.	Sulfate of potash	______

7. How does soil pH levels affect the availability of phosphorus and potassium?

8. Determine the ratios for the following fertilizer mixes:

analysis	= 3-9-27	3-12-12	5-20-20
ratio	= 1-3-09	1- 4- 4	1- 4- 4
analysis	= 7-28-14	12-12-12	6-24-24
	= 1- 4- 2	1- 1- 1	1- 4- 4

A. The first number in the ratio is ____________
B. The second number in the ratio is ____________
C. The third number in the ratio is ____________

9. Why are fertilizer ratios important?

10. A 150 bushel corn crop will contain how much?

A. P_2O_5 ________

B. K_2O ________

11. How do the soils of Illinois differ in their potassium level and why?

12. What crops require the largest amounts of potassium?

13. Are the soils in your region of Illinois naturally low or naturally high in potassium?

14. What is the formula for determining the amount of a potash fertilizer to use?

15. Why should potash not be applied close to seeds?

16. Which crops tend to "luxury feed" on potassium?

17. How much K_2O can be applied through a grain drill for small grains?

18. What is the phosphorus-supplying power in your region of Illinois?

19. What factors influence the phosphorus-supplying power of a soil?

20. As an average for Illinois soils, about how many pounds of P_2O_5 does it take to increase the P_1 soil test by 1 pound?

21. As an average for Illinois soils, about how many pounds of K_2O are required to raise the K soil test by 1 pound?

22. What are good test readings for pH, P, and K?

pH =

P =

K =

WORKSHEET 4

SECONDARY, MICRONUTRIENTS AND SOIL LIMING

1. List the elements that are classified as secondary nutrients and give their chemical symbol.

2. Why has there been an increase in reported sulfur deficiencies in the Midwest in recent years?

3. What is the primary source of sulfur in soils?

4. List the elements that are classified as essential micronutrients and give their chemical symbol.

5. On which plants have there been confirmed deficiencies of micronutrients in Illinois?

6. Under what conditions are micronutrient deficiencies likely to appear?

7. Why is it necessary to lime soils in Illinois?

8. What test is used to determine soil acidity levels?

9. How is the pH test read?

10. What are the desired pH ranges for Illinois soils?

11. What materials are commonly used in Illinois to raise pH levels?

Other materials are:

12. What factors should be considered when selecting liming materials?

13. How is lime generally applied?

14. When should lime be applied?

WORKSHEET 5

DETERMINING FERTILIZER RATES AND COSTS

1. Calculate the pounds of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) available in the fertilizer below.

   100 lbs. of 10-20-10

2. Using local prices or the sample prices for fertilizer and crops, calculate the cost of fertilizing 200 acres of corn (second year in a c-c-s rotation) using about:

   125 lbs. of N per acres,

   100 lbs. of P_2O_5 per acre

   100 lbs. of K_2O^5 per acre.

   Use the following fertilizers:

   Anhydrous Ammonia,
   0-46-0,
   0-0-60.

3. On 50 acres, the average soil test reading is 160 for potassium and 12 for phosphorus.

   A. Determine the soil phosphorus and potassium supplying power for soils in your local region of Illinois. Then, report the pounds of P_2O_5 and K_2O needed per acre.

   ____ P_2O_5 needed/acre
   ____ K_2O needed/acre

   B. Select a fertilizer blend from the Sample Fertilizer and Crop Price List.

   C. Determine the fertilizer cost for the 50 acres and cost for one acre.

Sample Fertilizer & Crop Price List

NH_4^+	$270 per ton
18-[illegible]-0	$275 per ton
0-46-0	$205 per ton
0-0-60	$102 per ton
28-0-0	$156.20 per ton
8-32-16	$200 per ton
9-23-30	$200 per ton
6-24-24	$200 per ton
$CACO_3$ =	$8.25 per ton

Delivery $3.00 per ton

Blending $4.00 per ton

Buggy $4.00 per ton

Spreading NH_4^+ 2.00 per acre

NH_{4+} Applicators $7.00 per ton.

Crop prices

corn = $3.10
soybeans = $7.20
wheat = $3.50

STUDENT JOB SHEET

COMPARING THE EFFECTS OF FERTILIZERS

I. Objective: To determine how fertilizers containing different analysis affect plant growth.

II. Materials:

1. 100 ft. measuring tape
2. string or lime marker
3. about 25 lbs. of different fertilizer mixes such as:

   5-10-10
   13-0-44
   20-20-20
   18-46-0
   0-0-60

4. lawn fertilizer spreader

III. Procedures:

1. Locate a part of the school grounds and mark out equal size plots.
2. Determine an acceptable rate of fertilizer per plot.
3. Adjust the lawn spreader according to the instructor's manual.
4. Spread one analysis of fertilizer on each plot and make observations weekly.
5. Prepare a map of the fertilized plots.

IV. Questions:

A. How many square feet are in one acre? _____

B. How do you convert from lbs./acre to lbs./100 square feet?

C. How do you determine the area of a rectangle?

D. What would be the approximate dimensions of a square which is 1/1000 of an acre? 1/100 of an acre?

V. Observations: Record your observations weekly. Note the difference in growth rates, color, hardiness, etc. of the grass in each plot.

VI. Conclusions: Relate the observations you made on the plots to how you would plan a fertilizer program for your crop S.O.E.P.

Teacher's Key

STUDENT WORKSHEET 3

MAJOR PLANT NUTRIENTS

Part A. Nitrogen

1. Name the three major plant nutrients and the chemical symbol for each.

	Nutrient	Symbol
A.	Nitrogen	N
B.	Phosphorus	P
C.	Potassium	K

2. What are the two forms of nitrogen that plants take up in the soil?

A.	Ammonium	NH_4^+
B.	Nitrate	NO_3

3. What do soil bacteria do to soil nitrogen.

Change nitrogen to a form which
is usable to the plants.

4. What are the benefits of providing adequate nitrogen?

Dark green color
Rapid vegetative growth
Efficient use of available moisture
Increases yields
Improves quality of crops
Increases protein content
Aids micro-organisms when decomposing
low-nitrogen organic materials

5. What is the nutrient content of 150 bu. corn crop?

Elements	Lbs.
N	235
P_2O_5	90
K_2O	185

6. Commercial fertilizers are available in what three forms?

gas
solid
liquid

7. What factors should be considered before purchasing fertilizer materials?

Amount of nutrients needed
Nutrient requirements of crop to be grown
Plant population
Expected yield
Soil conditions--pH, drainage, organic matter
Cost
Availability of materials

8. Name the common carriers of nitrogen and give their percentage of available nitrogen and their form.

Gas - Anhydrous ammonis - 82%

Solid - Ammonium nitrate - 33%
- Diammonium phosphate - 18%
- Urea - 46%

Liquid - Aqua - Ammonia - 20%
- Ammonium nitrate + urea - 20%
- Ammonia-Ammonium nitrate - 41%

9. Determine the current price per ton of the following nitrogen fertilizers:

		Price	Per Acre Cost of Application
A.	Ammonium nitrate	$	$
B.	Diammonium phosphate (DAP)	$	$
C.	Anhydrous ammonia	$	$
D.	Urea	$	$

Assume you want to apply 150 lbs. of nitrogen to 140 acres of corn. Find the total cost of the amount of nitrogen needed for each of the 4 forms of nitrogen. (Refer to VAS Unit 4009b, page 8, for an example)

10. What are the recommended amounts of nitrogen for:

    A. Corn in a corn-soybean rotation?

        125-225 lbs./acre

    B. Corn in a corn-soybean-wheat rotation?

        100-150 lbs./acre on prairie soils
        125-150 lbs./acre on timber soils

    C. Corn following clover sod?

        75-100 lbs./acre

    D. Soybeans?

        none recommended

    E. Winter wheat?

        15-20 lbs./acre in fall when seeding
        and 30-45 lbs./acre in spring

    F. Kentucky bluegrass?

        60-75 lbs./acre in early spring

11. Why can nitrogen be applied in the fall when the soil temperature drops below 50°F.

    Bacteria have become inactive and will not convert the nitrogen to a leachable form.

12. List the advantages and disadvantages of spring and fall applications of nitrogen.

(Refer to VAS Unit 4990b, Part 5, and
Illinois Agronomy Handbook, pages 40-41)

Part B. Phosphorus and Potassium

1. In what form is phosphorus expressed on a fertilizer bag? How do you convert this to percent phosphorus?

   P_2O_5 - phosphoric acid

   Multiply the percent of P_2O_5 by .44

2. In what form is potassium expressed on a fertilizer bag? How do you convert this to percent potassium?

   K_2O - potash

   Multiply the percent of K_2O by .83

3. What are the major functions of phosphorus in plants?

   Stimulates early root growth
   Promotes rapid starts
   Hastens plant maturity
   Stimulates blooming
   Promotes winter hardiness

4. What are the major functions of potassium in plants?

   Promotes vigor growth
   Promotes disease resistance
   Produces strong, stiff stalks
   Essential in formation of
     starches and sugars
   Promotes winter hardiness

5. Give the percent of P_2O_5 for the following phosphorus materials.

		% P_2O_5
A.	Super phosphate	16-22
B.	Triple super phosphate	44-47
C.	Mono-ammonium phosphate	46-48
D.	Diammonium phosphate	46
E.	Ammonium polyphosphate	34-37

6. Give the percent K_2O for the following potassium materials.

		% K_2O
A.	Muriate of potash	60
B.	Sulfate of potash	48

7. How does soil pH levels affect the availability of phosphorus and potassium?

   If the pH drops below 6.0, P and K both start to become unavailable to the plants.

If the pH rises above 7.0, P starts to become unavailable to the plants.

8. Determine the ratios for the following fertilizer mixes:

analysis	= 3-9-27	3-12-12	5-20-20
ratio	= 1-3-09	1- 4- 4	1- 4- 4
analysis	= 7-28-14	12-12-12	6-24-24
	= 1- 4- 2	1- 1- 1	1- 4- 4

A. The first number in the ratio is nitrogen

B. The second number in the ratio is phosphorus

C. The third number in the ratio is potassium

9. Why are fertilizer ratios important?

Different blends allow you to match your cropping needs.

10. A 150 bushel corn crop will contain how much?

A. P_2O_5 90 lbs.

B. K_2O 185 lbs.

11. How do the soils of Illinois differ in their potassium level and why?

(Refer to VAS Unit 4008a, Introduction)

12. What crops require the largest amounts of potassium?

corn, alfalfa, and clover

13. Are the soils in your region of Illinois naturally low or naturally high in potassium?

14. What is the formula for determining the amount of a potash fertilizer to use?

$$\frac{\text{pounds of } K_2O \text{ needed}}{\text{percent of } K_2O \text{ in the fertilizer used}} \times 100$$

15. Why should potash not be applied close to seeds?

can cause salt injury to the seed

16. Which crops tend to "luxury feed" on potassium?

forage legumes

17. How much K_2O can be applied through a grain drill for small grains?

Can apply up to 40 lbs. of K_2O

18. What is the phosphorus-supplying power in your region of Illinois?

19. What factors influence the phosphorus-supplying power of a soil?

(Refer to 1981-82 Illinois Agronomy Handbook, pp. 42-43)

20. As an average for Illinois soils, about how many pounds of P_2O_5 does it take to increase the P_1 soil test by 1 pound?

9 pounds of P_2O_5

21. As an average for Illinois soils, about how many pounds of K_2O are required to raise the K soil test by 1 pound?

4 pounds of K_2O

22. What are good test readings for pH, P, and K?

pH = 6.0-6.5

P = 40-50

K = 260-300

Teacher's Key

WORKSHEET 4

SECONDARY, MICRONUTRIENTS AND SOIL LIMING

1. List the elements that are classified as secondary nutrients and give their chemical symbol.

Calcium	CA
Magnesium	Mg
Sulfur	S

2. Why has there been an increase in reported sulfur deficiencies in the Midwest in recent years?

Increased use of sulfur-free fertilizer
Decreased use of sulfur as a fungicide and insecticide
Increased crop yields
Decreased atmospheric sulfur supply

3. What is the primary source of sulfur in soils?

Organic matter

4. List the elements that are classified as essential micronutrients and give their chemical symbol.

Zinc	Zn	Boron	B
Iron	Fe	Molybdenum	Mo
Manganese	Mn	Chlorine	Cl
Copper	Cu		

5. On which plants have there been confirmed deficiencies of micronutrients in Illinois?

Boron in alfalfa
Zinc in corn
Iron and manganese in soybeans

6. Under what conditions are micronutrient deficiencies likely to appear?

Strongly weathered soils
Course-textured soils
High pH soils
Organic soils
Soil very low in organic matter

7. Why is it necessary to lime soils in Illinois?

To neutralize acids that form in the soil

8. What test is used to determine soil acidity levels?

    pH test

9. How is the pH test read?

    pH less than 7.0 is acid
    pH of 7.0 is neutral
    pH greater than 7.0 is alkaline

10. What are the desired pH ranges for Illinois soils?

    Be maintained between 6.0 and 6.5

11. What materials are commonly used in Illinois to raise pH levels?

    Main source is agricultural ground limestone (lime)

    Other materials are:

    - Hydrated lime
    - Marl
    - Chats
    - Lime sludge

12. What factors should be considered when selecting liming materials?

    - neutralizing power
    - fineness
    - price
    - purpose and place of application

13. How is lime generally applied?

    by broadcasting

14. When should lime be applied?

    In spring for land plowed for corn or beans.
    In fall for land plowed for winter grains.
    On permanent pastures, lime before disking and seeding.

Teacher's Key

WORKSHEET 5

DETERMINING FERTILIZER RATES AND COSTS

1. Calculate the pounds of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) available in the fertilizer below.

   a. 100 lbs. of 10-20-10

   N = 10 lbs.

   P_2O_5 = 20 lbs.

   K_2) = 10 lbs.

2. Using local prices or the sample prices for fertilizer and crops, calculate the cost of fertilizing 200 acres of corn (second year in a c-c-s rotation) using about:

   125 lbs. of N per acres,

   100 lbs. of P_2O_5 per acre

   100 lbs. of K_2O_5 per acre.

   Use the following fertilizers:

   Anhydrous Ammonia,
   0-46-0,
   0-0-60.

200 x 150 lbs. N = 15 ton x \$270 = \$4050
200 x 200 lbs. P_2O_5 = 20 ton x \$205 = \$4100
200 x 170 lbs. K_2O = 17 ton x \$102 = \$1734
42 ton = Subtotal = \$9884

Delivery = 52 ton x \$3.00 = \$256.00
Blending = 37 ton x \$4.00 = \$148.00
Buggy = 37 ton x \$4.00 = \$148.00
NH_4^+ applicator = 15 ton x \$7.00 = \$105.00
SUBTOTAL = \$557.00

TOTAL \$10,441.00

Fertilizer cost per acre = \$52.00

3. On 50 acres, the average soil test reading is 160 for potassium and 12 for phosphorus.

A. Determine the soil phosphorus and potassium supplying power for soils in your local region of Illinois. Then, report the pounds of P_2O_5 and K_2O needed per acre.

____ P_2O_5 needed/acre
____ K_2O needed/acre

B. Select a fertilizer blend from the Sample Fertilizer and Crop Price List.

C. Determine the fertilizer cost for the 50 acres and cost for one acre.

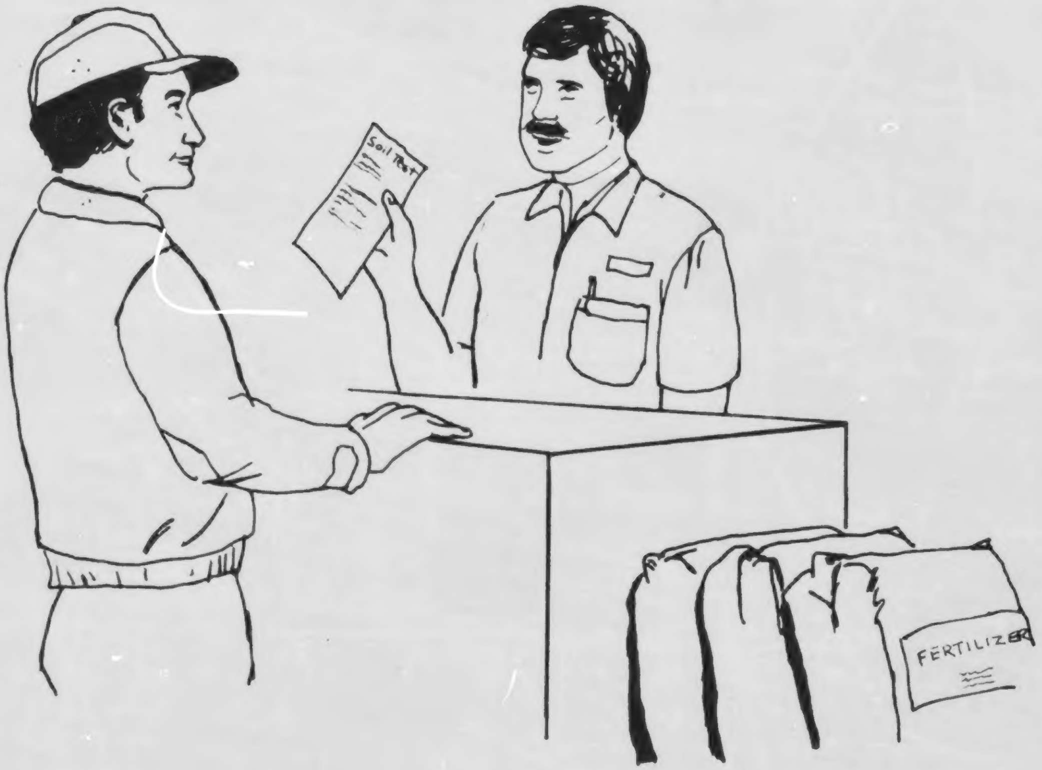
Sample Fertilizer & Crop Price List

NH_3^+	$270 per ton	Delivery $3.00 per ton
18-46-0	$275 per ton	Blending $4.00 per ton
0-46-0	$205 per ton	Buggy $4.00 per ton
0-0-60	$102 per ton	Spreading NH_4^+ 2.00 per acre
		NH_{4+} Applicators $7.00 per ton.
28-0-0	$156.20 per ton	
8-32-16	$200 per ton	
9-23-30	$200 per ton	
6-24-24	$200 per ton	
$CACO_3$ =	$8.25 per ton	

Crop prices

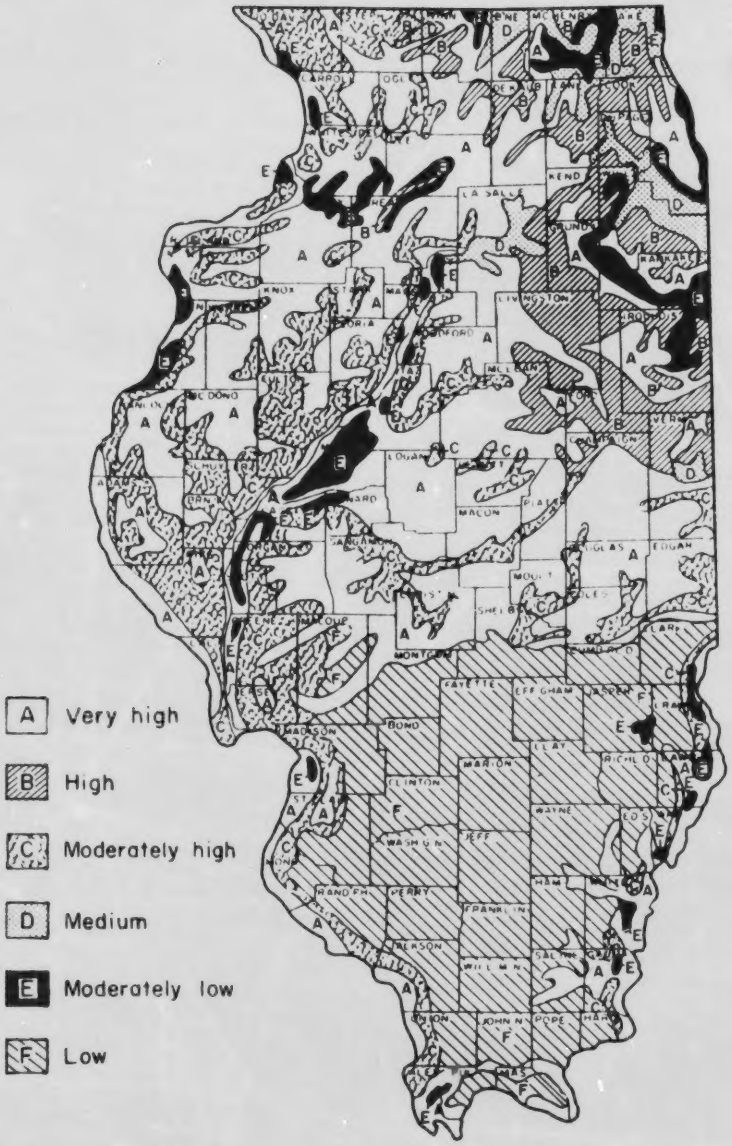
corn = $3.10
soybeans = $7.20
wheat = $3.50

ORDER FERTILIZER

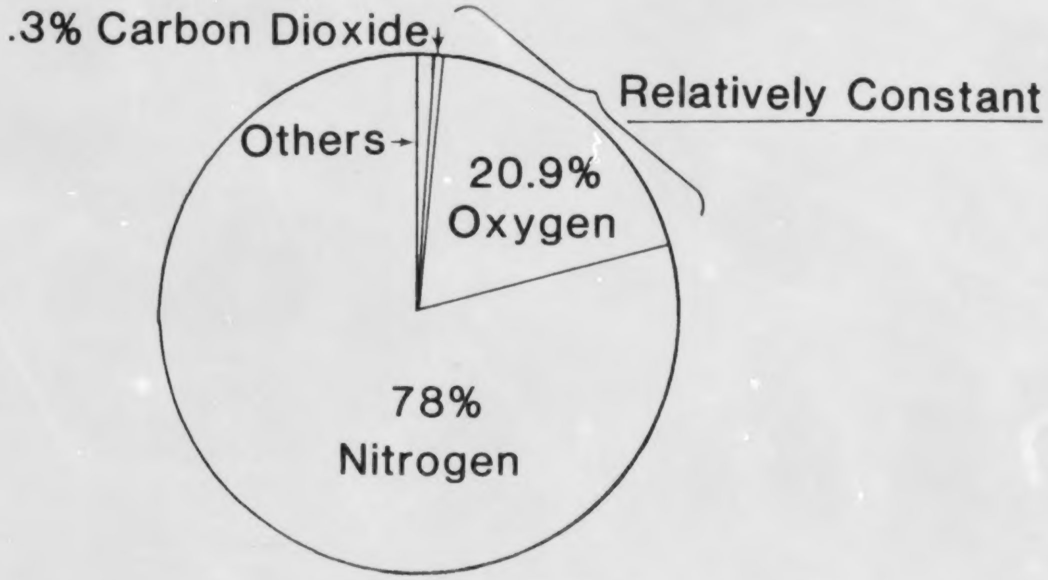

Soil Test
FERTILIZER

Follow the soil test recommendations and get the materials you need from your local supplier

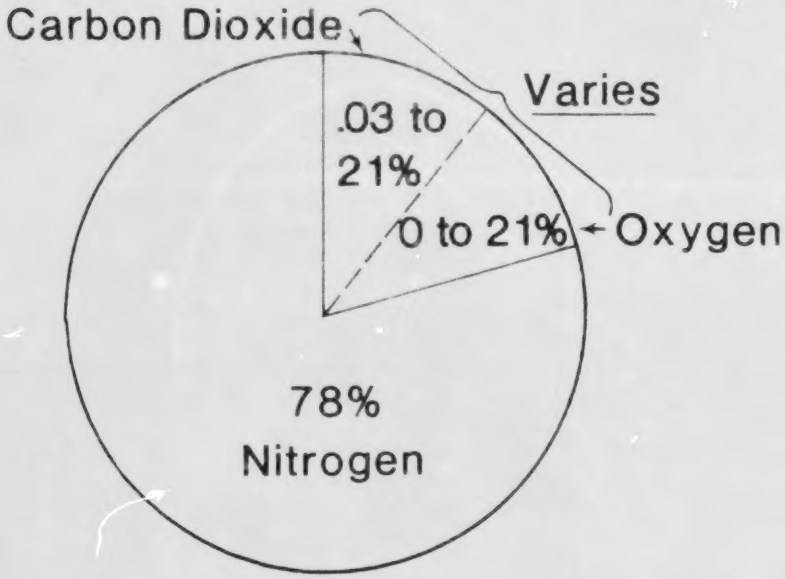
INHERENT FERTILITY LEVELS


A Very high
B High
C Moderately high
D Medium
E Moderately low
F Low
LA SALLE
LIVINGSTON
LOGAN
MACON
FAYETTE
BOND
MADISON
CLINTON
MARION
WAYNE
PERRY
FRANKLIN
POPE

COMPOSITION OF SOIL AND ATMOSPHERIC AIR

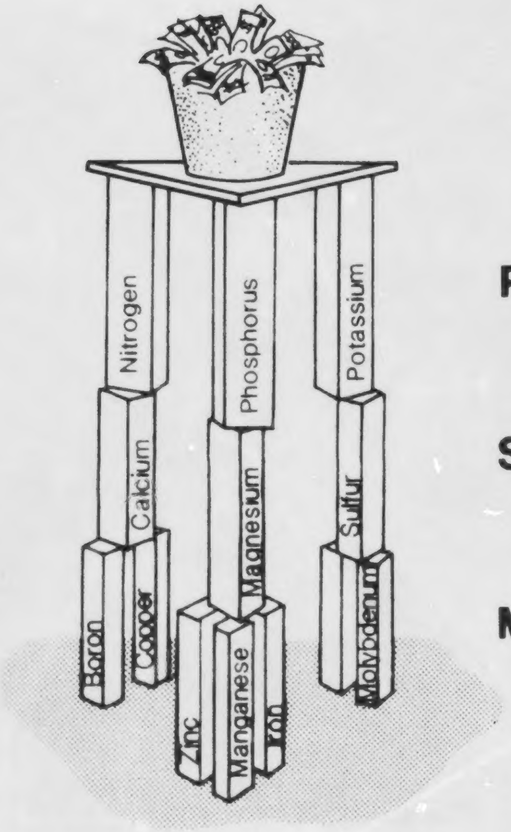


ATMOSPHERIC AIR



SOIL AIR

PROFITS CAN FALL IF ANY NUTRIENT IS SHORT


Nitrogen
Phosphorus
Potassium
Calcium
Magnesium
Sulfur
Boron
Copper
Zinc
Manganese
Iron
Molybdenum

Primary plant nutrients

Secondary plant nutrients

Micro plant nutrients

For high profits all nutrients must be present and in balance.

NUTRIENTS IN FERTILIZERS

PRIMARY

N	Nitrogen
P	Phosphorus in Fertilizer Phosphate--P_2O_5
K	Potassium in Fertilizer Potash--K_2O

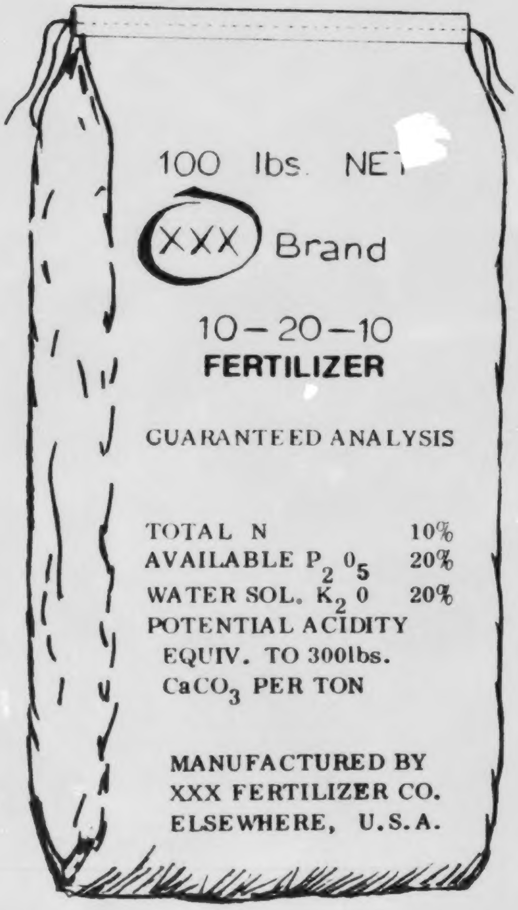
SECONDARY

Ca	Calcium
Mg	Magnesium
S	Sulfur

MICRONUTRIENTS

B	Boron
Cu	Copper
Fe	Iron
Mn	Manganese
Mo	Molybdenum
Zn	Zinc
Cl	Chlorine

INFORMATION COMMONLY FOUND ON A FERTILIZER BAG


100 lbs. NET
XXX Brand
10–20–10
FERTILIZER
GUARANTEED ANALYSIS
TOTAL N 10%
AVAILABLE P_2O_5 20%
WATER SOL. K_2O 20%
POTENTIAL ACIDITY
EQUIV. TO 300lbs.
$CaCO_3$ PER TON
MANUFACTURED BY
XXX FERTILIZER CO.
ELSEWHERE, U.S.A.

Lbs. per Bag

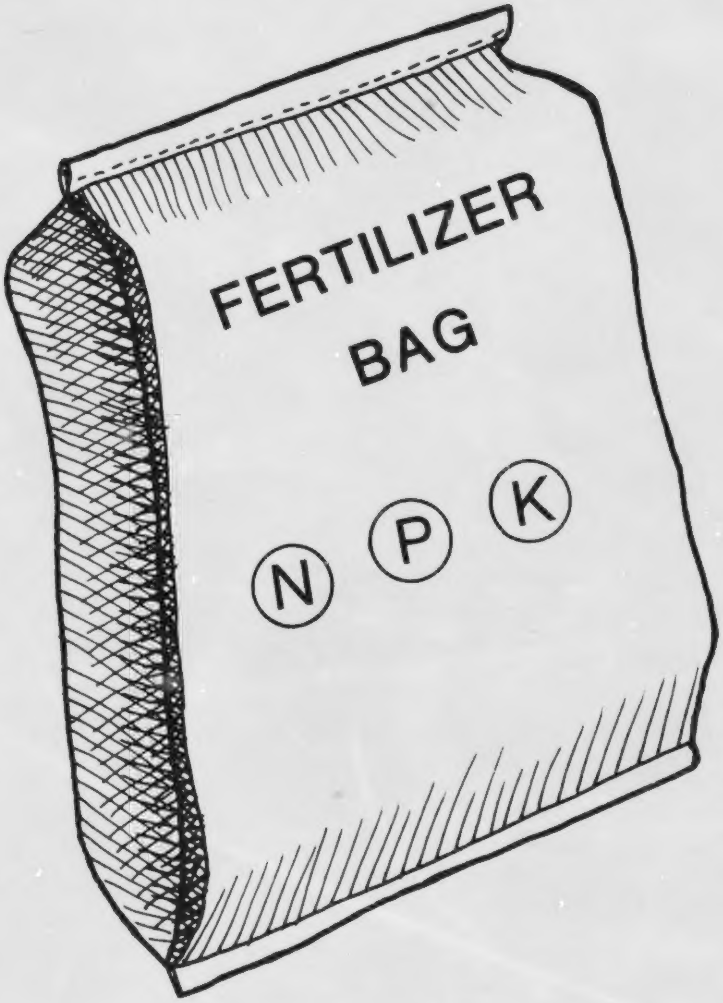
Name or Brand of Fertilizer

Chemical Composition Guaranteed

Acid Forming Tendency

Name & Address of Manufacturer

PRIMARY NUTRIENTS IN A FERTILIZER MIX

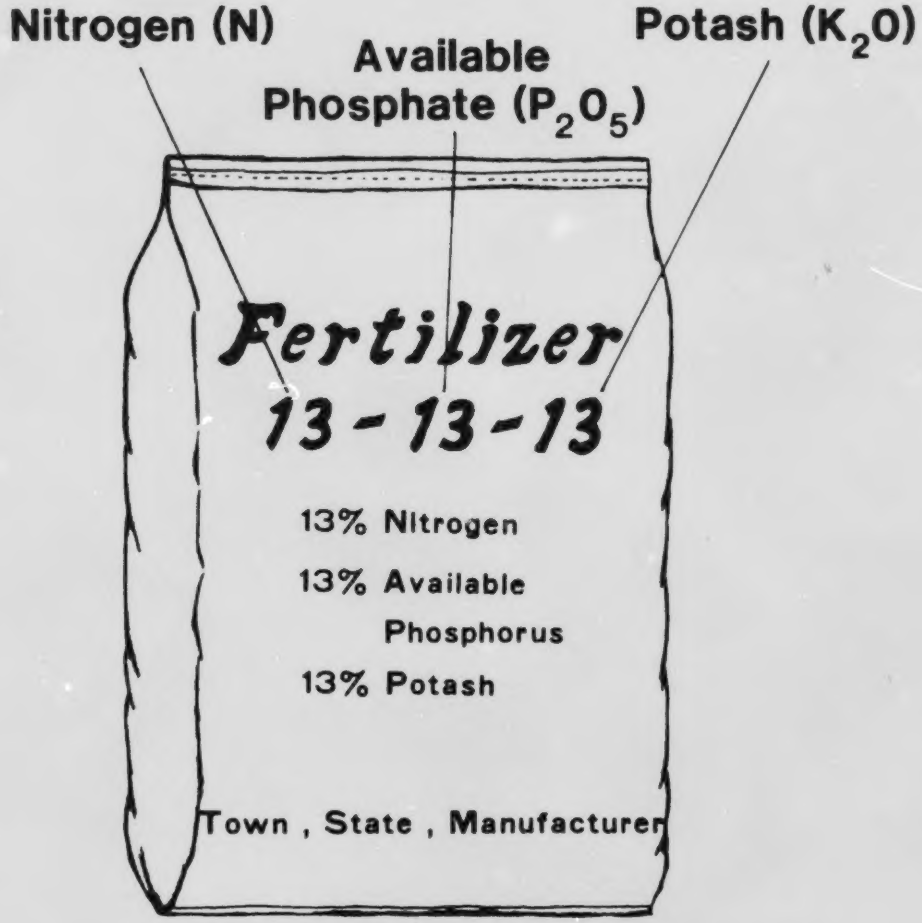

FERTILIZER
BAG
N
P
K

FERTILIZER ANALYSIS

20 - 10 - 10

20	10	10
Total Nitrogen Available	Total Phosphorus Expressed as P_2O_5	Water Soluble Potash Expressed as K_2O

PLANT NUTRIENT BLENDS


Nitrogen (N)
Available Phosphate (P_2O_5)
Potash (K_2O)
Fertilizer
13 - 13 - 13
13% Nitrogen
13% Available Phosphorus
13% Potash
Town , State , Manufacturer

13 N — 13 P_2O_5 — 13 K_2O = 1—1—1 Ratio

13 Lbs. of Each Primary Nutrient =
39 Lbs. per 100 Lbs. of Fertilizer

PRIMARY PLANT NUTRIENTS

1.	N	Nitrogen
2.	P	Phosphorus
3.	K	Potassium

NITROGEN

FUNCTION IN PLANTS

An adequate supply:

1. Produces vegetative growth.
2. Gives dark-green color to plants.
3. Feeds soil micro-organisms during their decomposition of low-nitrogen organic materials.
4. Increases efficiency of available moisture.

HUNGER SIGNS

1. Yellowing starting at the tip and extending down the midribs of the lower leaves.
2. Slow and dwarfed growth.
3. Poor root system.

MOVEMENT IN SOIL

1. In the ammonium form, nitrogen moves very little after it is absorbed by the clay particles.
2. In the nitrate form, nitrogen moves with soil moisture; consequently, nitrate nitrogen will be more apt to leach on sandy soils than in heavier clays and clay loams since water movement will be greater.

PHOSPHORUS

FUNCTION IN PLANTS

1. Stimulates early root formation
2. Gives rapid and vigorous start.
3. Hastens maturity.
4. Stimulates blooming.
5. Gives winter hardiness.

HUNGER SIGNS

1. Stunted growth.
2. Slow maturity.
3. Low yield of fruit and seed.
4. Purpling of leaves, stems, and branches in plants.

MOVEMENT IN SOIL

Phosphorus moves very little from its point of application.

POTASSIUM

FUNCTION IN PLANTS

1. Imparts increased vigor and disease resistance.
2. Produces strong, stiff stalks.
3. Essential to the formation and transfer of starches, sugars, and soils.
4. Imparts winter hardiness to crops.

HUNGER SIGNS

1. Scorching or burning of outer edges or tips of lower leaves.
2. Premature loss of leaves.

MOVEMENT IN SOIL

Potassium will move very little in heavy-textured clays and clay loams. It will move with soil moisture in lighter-textured sands and sandy loams.

SAMPLE PROBLEM

EXAMPLE:

How much Urea is required to provide 100 pounds of Nitrogen per acre?

SOLUTION:

1. Determine % of N in Urea from label.
2. Divide amount of N needed by percentage of N in fertilizer material.

$$\begin{array}{r}
222 \\
.45\,\overline{)\;100} \\
\underline{90} \\
100 \\
\underline{90} \\
100 \\
\underline{90} \\
10
\end{array}$$

ANSWER:

222 pounds per acre of Urea.

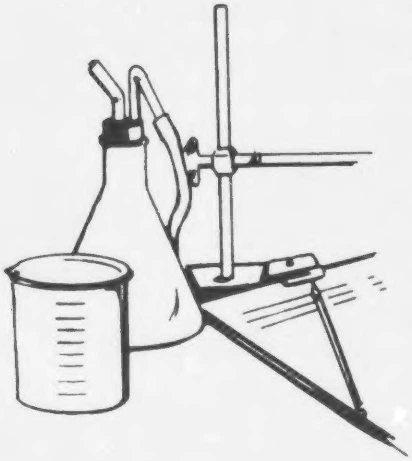
SOIL ACIDITY

Acidity is a relative concentration of H^+ ions.

A low pH causes an excess of:

Manganese
Aluminum
Iron

Toxic



This leads to **deficiency** of:

Calcium
Magnesium
Potassium
Phosphorus
Nitrate

USING LIMESTONE

Lime or Limestone
= Calcium Carbonate
= $CaCO_3$

Dolomite or Dolomitic Limestone
= Calcium+Magnesium Carbonate

Benefits

1. Raises pH
   - Reduces solubility of toxic aluminum, iron, manganese
   - Speeds up bacterial life
     - more nitrogen available
   - Increase phosphate available
2. Adds Ca and Mg

TRANSPARENCY DISCUSSION GUIDE

BUYING AND USING FERTILIZERS

I. Transparency - ORDER FERTILIZER

   A. Review the importance of taking regular soil tests in order to help plan a complete fertility program.

   B. Discuss the information found on a soil test report.

   C. Point out the hazards of under-applying or over-applying fertilizer.

II. Transparency - INHERENT FERTILITY LEVELS

   A. Point out the variation in the fertility levels of Illinois soils.

   B. Identify the fertility level of the soils located around your local community.

   C. Discuss how a soil's inherent fertility affects a farmer's fertilizer program. Point out the characteristics of each area. The fertility level in each area is:

      1. Area A - high N, P, & K with medium to slightly acid.
      2. Area B - fairly high N and K, generally low in P. Medium to slightly acid.
      3. Area C - high in P and K, but low in N. Medium to strongly acid.
      4. Area D - high in K. Low in N and P. Medium to strongly acid.
      5. Area E - quite variable in fertility. Slight to strongly acid. Soils tend to be sandy and gravelly.
      6. Area F - Low in N and medium to low in P and K. Strong to very strongly acid.

III. Transparency - COMPOSITION OF SOIL, ATMOSPHERIC AIR

   A. Discuss the similarities between soil air and atmospheric air.

   B. Point out the importance of oxygen to plant roots.

IV. Transparencies - PROFITS CAN FALL SHORT IF ANY NUTRIENT IS SHORT, NUTRIENTS IN FERTILIZERS

   A. Discuss the importance of a balanced fertility program.

B. Identify the essential elements for plant growth and the chemical symbols for each.

C. Discuss the differences between Primary, Secondary, and Micronutrients.

V. Transparencies - INFORMATION COMMONLY FOUND ON A FERTILIZER BAG, PRIMARY NUTRIENTS IN A FERTILIZER MIX

A. Point out the primary information which must be printed on a fertilizer bag.

B. Display examples of fertilizer bags and have students look for this information.

C. Point out the major nutrients contained in fertilizer.

VI. Transparencies - FERTILIZER ANALYSIS, PLANT NUTRIENT BLENDS

A. Point out the nutrients each number represents on a fertilizer analysis.

B. Discuss the chemical form each nutrient is in.

C. Calculate the total amount of fertilizer in a 100 pound bag when given different analysis.

D. Define what is meant by the fertilizer ratio and why it is important to know this when purchasing fertilizer.

VII. Transparencies - PRIMARY PLANT NUTRIENTS, NITROGEN, PHOSPHORUS, POTASSIUM

A. Point out that these three elements are contained in a complete fertilizer.

B. Briefly discuss the functions, hunger signs, and movement in soil for each nutrient.

C. Identify or show crop pictures depicting nutrient hunger signs.

VIII. Transparency - SAMPLE PROBLEM

A. Use this transparency to help explain and demonstrate how to calculate actual nutrient content of different forms of fertilizer.

B. Provide other examples for students to work to calculate nutrient content.

IX. Transparencies - ACIDITY, LIME OR LIMESTONE

A. Define pH.

B. Discuss the importance of proper soil pH.

C. Identify the pH levels which are desirable for common crops.

D. Point out which materials are commonly used to raise soil pH levels.

TEACHER'S KEY

SAMPLE TEST QUESTIONS

BUYING AND USING FERTILIZERS

True or False

T 1. To apply 60 pounds of P_2O_5 you would need to put on 300 pounds of super phosphate.

T 2. Dolomitic limestone contains both calcium and magnesium.

F 3. A good time to apply limestone is on top of the clover after wheat has been harvested in July.

F 4. Purple coloring of young corn indicates a deficiency of potassium.

T 5. Nitrate nitrogen is more likely to leach than ammonium nitrogen.

F 6. Boron is a major plant nutrient.

F 7. An acid soil is the same as an alkaline soil.

T 8. A P_1 test of 40 is a good goal for corn land.

T 9. Exchangeable potassium is available for plant use.

T 10. Corn and clovers are the biggest users of potassium.

F 11. 100 bushel corn requires at least 150 pounds of N.

F 12. Triple super phosphate is 20 percent P_2O_5.

F 13. Heavy applications of phosphorus on winter wheat will cause lodging.

F 14. Sulfate potash is 48 percent P_2O_5.

F 15. CEC stands for calcium exchange capacity.

F 16. Limestone should always be plowed down.

F 17. Chats, a by-product of lead mining, is the most commonly used liming material in Illinois.

T 18. Wheat and clovers are heavy users of phosphorus.

F 19. Potassium is often used to sidedress corn.

F 20. Soybeans usually respond very well to nitrogen fertilizer.

T 21. A common method of applying nitrogen to wheat is topdressing in the spring.

T 22. A soil with a pH of 6.2 is acid.

F 23. Micronutrients are not essential to plant growth.

T 24. Legumes can obtain nitrogen from the air and soil through a bacteria.

T 25. The nitrogen in organic matter is not in a available form for plant use.

T 26. Ammonium nitrogen will not quickly change to nitrate nitrogen when the soil temperature is below 50°F.

T 27. Ammonium nitrate is 33 percent nitrogen.

T 28. Plants use most of their nitrogen in the nitrate form.

F 29. pH stands for "parts of hydrogen."

F 30. Copper is a secondary plant nutrient.

F 31. Acid soils are bad for all crops.

F 32. Lime should be applied every year.

T 33. A higher level of pH is needed for alfalfa than for corn.

T 34. Most lime has a neutralizing power between 65% and 109%.

T 35. Hydrated lime reacts very quickly and is more expensive than ag. lime.

F 36. Lime cannot be applied to permanent pasture.

T 37. The atmosphere contains a large percentage of nitrogen.

F 38. Corn uses more phosphorus than any other nutrient.

T 39. The most frequently used form of potassium in Illinois is muriate of potash.

T 40. Manure is an unbalanced fertilizer.

Completion
Nitrogen

1. The two forms of nitrogen which are available to plants are ammonium NH_4 and nitrate No_3.
2. The form of nitrogen most likely to leach is nitrate.
3. Nitrogen deficiency on a corn plant shows up as firing of lower leaves-tip down midrib.

4. The maximum amount of nitrogen that should be applied to winter wheat is about 40 pounds per acre.

5. The most commonly used form of nitrogen in our area is ____________.

6. Pound for pound, the nitrogen fertilizer that is usually the most economical is anhydrous ammonia.

7. The nitrogen fertilizer most commony used on winter wheat in our area is ______________________________.

8. Nitrogen application in the fall should be delayed until the soil temperature at 4 inches is 50 degrees F. or lower.

9. Plants that can take as much as 2/3 of their nitrogen from the air and soil are called legumes.

10. 150 bushel corn crop contains about 235 pounds of nitrogen

11. Anhydrous ammonia is about 82% actual nitrogen.

12. Ammonium nitrate is about 33% actual nitrogen.

13. Three advantages of applying nitrogen in the fall are cheaper, available labor, available material.

14. Urea is about 45% actual nitrogen.

15. Excess nitrogen on wheat causes lodging.

16. To get 123 pounds of nitrogen you need to apply about 150 pounds of anhydrous ammonia.

17. The amount of nitrogen which should be applied to soybeans to get a 40 bushel yield is none pounds.

18. Volitalization is changing from a solid to a gas.

19. When crops fall over and are on the ground, this is called lodging.

20. About 10-15% more nitrogen should be put on in the fall than what you would apply in the spring.

21. If you apply 200 pounds of urea, how much actual nitrogen are you applying? 92 pounds.

22. Ammonium nitrate is held in the soil by the clay and organic matter.

23. Corn uses most of its nitrogen during the first three months of growth.

24. Inoculation is applying N fixing bacteria to the soil.

Completion
Phosphorus

1. Two crops that are heavy users of phosphate are wheat and clovers.

2. The P_1 soil test reports the amount of available phosphorus.

3. Name three soluble phosphate fertilizers and give the approximate % P_2O_5 of each.

a.	superphosphate	16-22%
b.	triple superphosphate	44-47%
c.	diammonium phosphate	46%

4. A phosphorus deficient corn plant will develop a purple color.

5. The name of P_2O_5 is phosphoric acid.

6. A soil test tells you that you need 60 pounds of P_2O_5 per acre. How much superphosphate would you need? 300 pounds.

7. A fertilizer bag has 10-24-18 on it. It contains how much actual phosphorus (P) in a 100 pound bag. 10.56 pounds.

8. The form of phosphorus which is available to plants is H_2PO_4.

9. P_2O_5 is 44% actual phosphorus.

10. A 150 bushel corn crop contains about 90 pounds of P_2O_5.

Completion
Potassium

1. The most commonly used potash fertilizer in Illinois is muriate of potash.

2. Muriate of potash contain 60% K_2O.

3. The maximum amount of K_2O that should be applied through a grain drill for small grains is about 40 pounds.

4. Three crops which are big users of potassium are corn, clover, and alfalfa.

5. A corn plant that is deficient in potassium will fire down margins of leaves.

6. K_2O is 83% actual K.

7. Potassium should not be applied close to seeds because burn the seeds - salt injury.

8. The crops that "luxury feed" on potassium are forage legumes.

9. A 150 bushel corn crop contains about 185 pounds of K_2.

10. The formula for determining the amount of a potash fertilizer to use is

$$\frac{\text{1bs. } K_2O \text{ needed}}{\% \ K_2O \text{ in fertilizer}} \times 100$$

Completion
Secondary and Micronutrients

1. The best way to keep check on soil acidity levels is by soil testing.
2. The most desirable pH range for farm crops is between 6.0 and 6.5 .
3. A soil with a pH level below 7.0 would be consideed acid, above 7.0 would be considered basic, and exactly 7.0 would be considered neutral.
4. Lime is composed of calcium carbonate.
5. Dolomitic limestone is composed of calcium and magnesium.
6. A high concentration of H^+ ions is termed acidity.
7. Two major plant nutrients which become limited as acidity increases are phosphorus and potassium.
8. The element that corrects soil acidity is calcium.
9. Nutrients which are used only in trace amounts per acre are called micronutrients.
10. The element which is an essential part of chlorophyll is magnesium.
11. The test that measures soil acidity is pH.
12. Four factors which should be considered in selectng a liming material are price, fineness, neutralizing power, and availability.

Multiple Choice

C 1. Which is not a soluble phosphate fertilizer.

a. superphosphate
b. triple superphosphate
c. rock phosphate
d. diammonium phosphate

D 2. The soil test for soluble phosphorus is:

a. P_2
b. A_1
c. pH
D. P_1

_C_ 3. The K test that should be your goal for corn is:

a. 60 c. 300
b. 90 d. 150

_A_ 4. Limestone is applied in:

a. tons c. ounces
b. pounds d. gallons

_B_ 5. A soil with a pH of 7.5 is:

a. acid c. sour
b. alkaline d. neutral

_C_ 6. The percent of nitrogen in urea is:

a. 20 c. 45
b. 33 d. 82

_B_ 7. Which is not a potassium fertilizer

a. muriate of potash c. 0-0-60
b. nitrate of soda d. KC1

_A_ 8. The most common way of applying limestone is by:

a. truck c. easy flow
b. knifing in d. planter hoppers

_D_ 9. The most common method of applying nitrogen to wheat in the spring is by:

a. sidedressing c. banding
b. knifing in d. topdressing

_B_ 10. Which is a nitrogen fertilizer:

a. 0-20-0 c. 0-0-20
b. 20-0-0 f. 0-82-0

Matching

1. Using the symbols:
P = Primary nutrient
S = Secondary nutrient
M = Micronutrient

Place the correct letter beside each element.

P Nitrogen
M Boron
S Calcium
M Zinc
P Phosphorus
M Molybdenum

S Sulfur
S Magnesium
M Manganese
P Potassium
M Copper
M Iron

2. Give the ratios of the following fertilizer mixes:

3-9-27 1-3-9
12-12-12 1-1-1
3-12-12 1-4-4
6-24-24 1-4-4

5-20-20 1-4-4
7-28-14 1-4-2
6-12-18 1-2-3
4-12-16 1-3-4

3. Match the term in column 1 with those in column 2.

	Column 1		Column 2
E	Rock phosphate	A.	Muriate of potash
A	KC1	B.	20% P_2O_5
B	Super phosphate	C.	most widely used
C	Piammonium phosphate	D.	63% P_2O_5
D	Triple superphosphate	E.	seldom used anymore

4.

	Column 1		Column 2
B	Anhydrous ammonia	A.	contains phosphates
A	DAP	B.	cheapest form of N per pound
D	Ammonium nitrate	C.	45% nitrogen
C	Urea	D.	33% nitrogen

5.

	Column 1		Column 2
C	Hydrated lime	A.	remains from lead mining
D	$CaCO_3$	B.	dolomitic lime
B	$MgCO_3$	C.	expensive
A	Chats	D.	most widely used

Essay

1. What factors determine how much fertilizer a person should apply to a field?

2. Identify the characteristic of a plant with adequate nitrogen.

3. Identify three factors which should be considered in deciding when to apply fertilizer.

4. If urea and anhydrous ammonia both cost $200 per ton. Which would be the better buy? Why?

5. Explain why legumes do not need nitrogen fertilizer.

UNIT G: Horticulture

PROBLEM AREAS:

1. Identifying trees, shrubs, and flowers
2. Propagating plants sexually and asexually
3. Growing and caring for indoor plants

UNIT G: HORTICULTURE

PROBLEM AREA: IDENTIFYING TREES, SHRUBS AND FLOWERS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade or second-year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is early fall. The estimated time for teaching this problem area is 5 to 10 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises.

Students interested in competing in the State Ornamental Horticulture Judging Contest may need to cover plants not listed in this problem area, and should refer to the IAVAT State Judging Contest Rules Booklet.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as teachers adapt this problem area to their local situation.

CREDIT SOURCES:

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The teacher's guide, worksheets, and test questions were developed by Ron Biondo, Department of Vocational and Technical Education, University of Illinois. The slidefilms, subject matter units and slide set were prepared by Vocational Agriculture Service, University of Illinois. The Teacher's Information Sheet was prepared by James Ethridge of Joliet Junior College.

Suggestions and guidance in the development of these materials were provided by Paul Hemp, Department of Vocational and Technical Education, University of Illinois and the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Horticulture

II. Problem area: Identifying trees, shrubs, and flowers

III. Objectives: At the close of this problem area students will:

1. Know basic terminology used in identifying trees, shrubs, and flowers.
2. Be able to identify 15 major Illinois trees by common name.
3. Be able to identify 10 evergreens by common name.
4. Be able to identify 9 shrubs most commonly used in landscaping by their common name.
5. Be able to identify 10 popular annual flowers grown in home gardens by their common name.
6. Be able to identify 10 bulbs or perennials grown in home gardens by their common name.

IV. Suggested interest approaches:

1. Have a local forester or horticulturalist visit the class as a guest speaker.
2. Ask the students to name as many trees, shrubs, and flowers with which they are familiar. Write the list on the chalkboard. Question them further by asking where the named plants can be located.
3. Raise the question: "Why is it important to be able to identify trees, shrubs, and flowers correctly?"
    a. Identification of horticulture plants is necessary in sales.
    b. Identification is vital in determining how to care for particular plants.

V. Anticipated problems and concerns:

1. What is meant by deciduous?
2. What is a compound leaf?
3. Can trees be identified during the winter months?

4. What are the major characterisitics to look for when identifying trees?
5. What are opposite buds?
6. When [illegible] best time of the year to identify most woody plants?
7. How do pines, firs and spruce differ?
8. What is a cone?
9. What is a fascicle?
10. How do needles differ from scale like leaves?
11. Do growth habits of pines change with time?
12. How do growth habits help in distinguishing shrubs?
13. When are shrubs considered small trees?
14. What is an annual?
15. What is a perennial?
16. What is an inflorescence?
17. Do all annuals grow well under the same conditions?

VI. Suggested learning activities and experiences:

1. Discuss the terminology used in identifying plants.
2. Have the students complete the worksheet "Woody Plant Terminology" using the Manual of Woody Landscape Plants.
3. Show VAS Slide Set S636 on tree identification and describe specific tree characteristics.
4. Take a walk in the local neighborhood and identify trees by their growth habit, bark, leaf shape, fruit and buds.
5. Have the students collect and correctly identify leaves and twigs from 15 different trees.
6. Provide the Job Sheet "Tree and Shrub Identification" to aid students in recording tree characterstics. Use the Manual of Woody Landscape Plants as a reference.
7. Show VAS Slidefilm 504 "Identifying Coniferous Trees."

8. Discuss the characteristics of conifers.

9. Provide the Job Sheet "Conifer Identification" to aid students in recording conifer characteristics.

10. Show VAS Slidefilms #660, 660-1.2, 661, 662, 662-1.2, on small shrubs, medium shrubs, and large shrubs.

11. Describe the major characteristics of small shrubs, medium shrubs, large shrubs and small trees.

12. Provide the Job Sheet "Tree and Shrub Identification" to aid the students in recording shrub characteristics.

13. Take a field trip to an arboretum. Point out the diversity of plant material. Continually quiz the students as you hike.

14. Visit a local garden center and review plant material commonly sold to the public.

15. Split the class into teams and have them compete in a plant materials scavenger hunt. (Suggested guidelines can be found in this problem area.)

16. Have the students record a tree and shrub fall color list.

17. Show VAS Slidefilms 601a and 602a on garden flowers, annuals.

18. Have the students complete the Worksheet "Garden Flower Terminology."

19. Take a walk in the local neighborhood, identify and discuss the uses of the different garden flowers, annuals and perennials.

20. Grow as many different types of annuals in the greenhouse as possible.

21. Utilize a portion of land on the school grounds to plant bulbs, perennial flowers and annual flowers.

22. Have the students order garden flower catalogs with photographs of annuals, bulbs, and perennials. Have the students cut out and mount pictures on 3 x 5 cards. They can then record plant characteristics on the card along side the photograph. (A garden flower catalog list is located toward the back of this problem area.)

23. Participate in the local, regional and state FFA Ornamental Horticulture Judging Contests.

24. Have the students make a list of all the ornamental plants grown at their home.

25. Discuss how plant identification can be the subject for Supervised Occupational Experience Programs (S.O.E.P.'s).

26. Have each student obtain a copy of "My Plant Diary" from Vocational Agriculture Service and record specific plant characteristics.

VII. Application procedures:

1. Plants must be correctly identified in order to meet the proper cultural requirements of the plant.

2. The identification skills should be put to use when selecting landscape plants.

3. The identification skills learned will aid students working at garden centers, nurseries, parks, arboretums, florists, landscaping firms, etc.

VIII. Evaluation:

1. Collect and grade worksheets and job sheets

2. Administer quizzes upon the completion of each identification section (i.e. trees, evergreens, shrubs, annuals, perennials). Divide the class into teams and record scores for both individual and team performance. Reward the best team and individual scores by letting them compete in regional or state competition.

3. Administer and grade a test at the completion of the problem area.

IX. References and aids:

1. Manual of Woody Landscape Plants, M. A. Dirr, Stipes Publishing Co., Champaign, Illinois. Copyright, 1975.

2. Time-Life Books on Annuals and Perennials.

3. University of Illinois, College of Agriculture, Vocational Agriculture Service

   a. Slidefilms:

504	"Identifying Coniferous Trees"	59 frames
601a	"Garden Flowers, Annuals"- Pt. 1	50 frames
602a	"Garden Flowers, Annuals"- Pt. 2	50 frames
660	"Recognizing Small Shrubs"	38 frames
660-1.2	"Recognizing Small Shrubs"- Pt. 2	32 frames
661	"Recognizing Medium Size Shrubs"	37 frames

662	"Recognizing Large Shrubs & Small Trees"	38 frames
662-1.2	"Recognizing Large Shrubs"-Pt. 2	55 frames

b. Slide Set:

S363	"Tree Identification"	200 frames

c. Subject Matter Units:

5001	"Selecting Trees for Home Planting"-	40 pages
5010a	"Growing Flowering Annuals"-	24 pages

4. University of Illinois Cooperative Extension Service:

   Horticulture Facts Sheet

   FL - 2-79 Flowering Annuals and Bedding Plants: Publications, Films and Slide Sets

5. Information Sheets included in this problem area:

   a. "Nomenclature"
   b. "Suggested Garden Annuals"
   c. "Suggested Garden Perennials and Bulbs"
   d. "Partial Listing of Major Seedmen"
   e. "Garden Flowers: Partial List of Catalogs"

TEACHER'S INFORMATION SHEET

NOMENCLATURE

Since the beginning of time, man has been classifying plants and animals. By using systems of classification, he has been able to determine the origin, reproductive habits, and other characteristics of living things. The system used to classify plants has made it much easier for the scientist to study plants.

It is essential that a student training for a horticultural occupation understand the classification of plants and how they were given their scientific names. The scientific names of plants are difficult to pronounce,. spell, and learn; but is is a sensible, convenient method of studying and identifying plants. Some of the advantages are as follows:

1. Scientific names of plants are used world-wide. The terms (nomenclature) used to describe plants were developed in Vienna in the early 1900's by botanists from many nations. Those attending this meeting developed the International Code of Botanical Nomenclature (a guide to be used in naming plants). It has been revised several times but is still in use today.
2. All plants are classified in the same manner. Their natural relationship is the basis for classification.
3. The common names of plants may differ from one area to another, but a horticulturist can order a plant by its botanical name and be sure of receiving the plant he or she ordered.
4. Scientific names of plants serve as a basis for standardizing all terminology used by horticulturists.
5. A knowledge of botanical names will help in identifying plants and eliminating confusion.

The scientific name given a plant usually is selected by the discoverer and is normally useful in describing or identifying the plant. However, this is not always true. Some of the names used that indicate the origin of plants are americana (America), koreana (Korea), orientalis (Orient), and virginicus (Virginia). Examples of people are baileyi, wilsoni, and fortunei. Descriptive terms used as names of plants are aborescens (treelike), campactus (compact), and nanus (dwarf). Some of the names used for plants may refer to the season of the year in which they bloom: autumale (autumn), praecox (very early), and aestivalis (spring). If the term "flors" is used as a part of the name, it describes something about the flower. The term may refer to quantity (floribunda), the size (grandiflora), or many flowers (multiflora).

Many people fail to pronounce the botanical names of greenhouse plants correctly; however, the pronunciation is not as important as the spelling. The botanical name of a plant must be spelled correctly in order for the plant to be properly identified.

The botanical name of a plant is composed of two Latin or Latinized words (for example, Spinacia olcracca). The first word is always capitalized and is the genus or generic name. The second word, called a specific epithet (a word or phrase accompanying or occuring in place of the name of a person or thing), is never capitalized. The words are never used alone in referring to a plant, and both words are required to correctly name the plant.

To designate a small difference in plants in a species, taxonomists often use a third word in the plant name. This is called a varietal name. The third word is often the name of the man who first named or described the plant. A horticultural variety is called a cultivar. These are cultivated plants selected for their outstanding feature(s).

Life Cycle Classification

Based on its life cycle, a plant may be classified as either an annual, biennial, or perennial.

An annual is a plant that completes its life cycle in one year. During this period, the plant blooms, produces seeds, and dies. It is said that an annual is a plant that goes "from seed to seed" in one year or in one growing season.

A biennial is a plant that requires two years or a part of two years to complete its life cycle. It goes "from seed to seed" in two years.

Perennials are plants that usually live for more than two years. There are of two kinds, herbaceous and woody. A herbaceous perennial is a plant that has soft, non-woody stems. Most of the herbaceous plants are annuals. Woody perennials are woody stemmed plants that live over winter. Some perennials produce stems and leaves the first year and fruit the second year.

Growth Habit Classification

Based upon their growth habits, plants are classified as trees, shrubs, and vines.

A tree is a woody perennial that has one erect or single stem which exceeds twelve feet in height, a trunk at least three inches in diameter at breast height (DBH), and definite crown, when fully grown.

A shrub, referred to by many as a bush, is a woody plant that arises from the ground with more than one stem and is usualy very low (attaining not more than twenty feet in height).

A vine is a plant that requires some type of support and climbs by tendrils or some other means, or creeps along the ground. It may be either a woody or herbaceous plant.

INFORMATION SHEET

SUGGESTED GARDEN ANNUALS

1.	*Celosia agentea cristata*	Cockscomb
2.	*Ageratum houstonianum*	Ageratum
3.	*Impatiens balsamina*	Touch-Me-Not
4.	*Coleus blumei*	Coleus
5.	*Tagetes patula*	Dwarf French Marigold
6.	*Pelargonium hortorum*	Geranium
7.	*Petunia hybrida*	Petunia
8.	*Portulaca grandiflora*	Moss Rose
9.	*Salvia splendens*	Salvia
10.	*Antirrhinum majus*	Snapdragon
11.	*Lobularia maritima*	Sweet Alyssum
12.	*Zinnia elegans*	Zinnia
13.	*Begonia semperflorens*	Wax Begonia

INFORMATION SHEET

SUGGESTED GARDEN PERENNIALS AND "BULBS"

1.	Caladium candidum	Caladium
2.	Canna hortenis	Canna
3.	Crocus sp.	Crocus
4.	Dahlia sp.	Dahlia
5.	Galdiolus byzantinus	Gladiola
6.	Hemerocallis citrina	Daylily
7.	Hosta sp.	Plantain Lily
8.	Hyacinths sp.	Hyacinth
9.	Iris sp.	Iris
10	Lilium sp.	Lily
11.	Chrysanthemum	Chrysanthemum
12.	Narcissus sp.	Daffodil
13.	Paeonia sp.	Peony
14.	Tulipa sp.	Tulip

INFORMATION SHEET

PARTIAL LISTING OF MAJOR SEEDSMEN

1977

Wholesale Seedsmen (W)

GEO. J. BALL, INC., Box 335, West Chicago, Ilinois 60185

BALL-SUPERIOR, LTD., (subsididary of Geo. J. Ball, Inc.), 1155 Birchview Drive, Mississauga, Ontario, Canada

W. ATLEE BURPEE CO., Court House Square, Clinton, Iowa 52732 (Also Pa. & Calif.)

FERRY-MORSE SEED CO., INC., P. O. Box 8, an Juan Bautista, California 95045

H. G. GERMAN SEEDS, Box N, 130 Bank St., Smethport, Pennsylvnaia 16749

GERMANIA SEED CO., 5952 N. Milwaukee Ave., Chicago, Illinois 60646

FRED C. GLOECKNER & CO., INC. 15 E. 26th St., New York, New York 10010

JOSEPH HARRIS CO., INC. Moreton Farm, 3670 Buffalo Rd., Rochester, New York 14624

HERBST BROS. SEEDSMEN, INC., 1000 N. Main St., Brewster, New York 10504

A. H. HUMMERT SEED CO., 2746 Chouteau Ave., St. Louis, Missouri 63103

HENRY F. MICHELL CO., Church Rd., King of Prussia, Pennsylvania 19406

NORTHRUP-KING & CO., 1500 Jackson St., N.E., Minneapolis, Minnesota 55413

PARK SEED WHOLESALE, INC., Cokesbury Rd., Greenwood, South Carolina 29646

STOKES SEEDS, INC., Box 548, Buffalo, New York 14240 (home office in Canada)

VAUGHAN-JACKLIN CORP. 5300 Katrine Ave., Downers Grove, Illinois 60515

Retail Seedsman (R)

BURGESS SEED & PLANT CO. (subsidiary of Geo. J. Ball, Inc.), Galeburg, Michigan 49053

BURNETT BROS., INC. 92 Chambers St., New York, New York 10007

W. ATLEE BURPEE CO. (see W)

FARMER SEED & NURSERY CO., Faribault, Minnesota 55021

HENRY FIELD SEED & NURSERY CO., Shenandoah, Iowa 51601

GURNEY SEED & NURSERY CO., Yankton, South Dakota 57078

JOSEPH HARRIS CO., INC. (see W)

JACKSON & PERKINS CO., 200 Rose Lane, Medford, Oregon 97501

J. W. JUNG SEED CO., Randolph, Wisconsin 53936

EARL E. MAY SEED & NURSERY CO., Shenandoah, Iowa 51601

L. L. OLDS SEED CO., Box 1069, Madison, Wisconsin 53701

GEO. W. PARK SEED CO., INC., Cokesbury Rd., Greenwood, South Carolina 29646 (see W)

SEEDWAY, INC., Hall, New York 14463

R. H. SHUMWAY, SEEDSMAN, 628 Cedar St., Rockford, Illinois 61101

STOKES SEEDS, INC., (see W)

THOMPSON & MORGAN, LTD., P. O. Boc 24, Somerdale, New Jersey 08083

OTIS S. TWILLEY SEED CO. Boc 1817, Salisbury, Maryland 21801

INFORMATION SHEET

GARDEN FLOWERS: PARTIAL LIST OF CATALOGS

Name	Specialty
Burpee Seeds Warminester, PA 18974	General line perennials (seeds only)
Conrad-Pyle Co. West Grove, PA 19390	Chrysanthemums and roses
De Jager and Sons, Inc. South Hamilton, MA 01982	Bulbs, iris and lilies
Dutch Gardens P.O. Box 30 Lisse, HOLLAND	Spring flowering bulbs (very good)
Interstate Nursery Hamburg, IO 51640	Roses, lilies, iris and general line perennials
Lamb Nurseries E. 101 Sharp Avenue Spokane, WA 99202	General line perennials
Lehamn Gardens Faribault, MN 55021	Chrysanthemums
McMormick Lilies P.O. Box 700 Canby, OR 97013	Lilies
Messelaar Bulb Co., Inc. County Road Route 1-A, Box 269 Ipswich, MA 01913	Fall and spring flowering bulbs
Grant E. Mitsch Canby, OR 97013	Daffodils
Oregon Bulb Farms Gresham, OR 97030	Lilies
Park Seed Co., Inc. Greenwood, SC 29647	General line perennials (seeds only)
Rex Bulb Farms Newberg, OR 97132	Lilies
Scheepers, Inc. 63 Wall Street New York, NY 10005	Bulbs, chrysanthemums and general line perennials

Name	Specialty
Schreiner's 3628 Quinaby Road, N.E. Salem, OR 97303	Iris
Smirnow Gardens 85 Linden Lane Glen Head P.O., Brookville Long Island, NY 11545	Tree peonies
Sunnyslope Gardens 8638 Huntington Drive San Gabriel, CA 91775	Chrysanthemums
Thon's 4815 Oak Street Crystal Lake, IL 60014	Chrysanthemums
Van Bourgondien's 245 Farmingdale Road Route 109, Box A Babylon, New York 11702	Bulbs and general line perennials
Walter Marx Gardens Boring, OR 97009	Iris, daylilies
Walter's Gardens, Inc. P.O. Box 137-96th Ave., M-21 Zeeland, MI 49464	General line perennials
Wayside Gardens Hodges, Se 29695	Bulbs, lilies, iris, peonies and general line perennials
Weller Co. P.O. Box 1111 Holland, MI 49423	General line perennials
White Flower Farm Litchfield, CT 06759	General line perennials (very good)
Wild and Sons, Inc. Sarcoxie, MO 64862	Peonies, iris, daylilies
Yoder Brothers, Inc. Barberton, OH 44203	Chrysthanemums

WORKSHEET

WOODY PLANT TERMINOLOGY

Matching

1. ___ Genus
2. ___ Alternate
3. ___ Deciduous
4. ___ Compound leaf
5. ___ Entire
6. ___ Species
7. ___ Fascicle
8. ___ Leaflet
9. ___ Lobe
10. ___ Node
11. ___ Cultivar
12. ___ Opposite
13. ___ Evergreen
14. ___ Palmate
15. ___ Petiole
16. ___ Simple leaf
17. ___ Whorl
18. ___ Pinnate
19. ___ Serrate
20. ___ Sinus

A. The joint on a stem
B. Cluster, as with needles of pine
C. Loses leaves in the fall
D. Fan-like, from a common point
E. Leaf stalk
F. The space between two lobes
G. Variety
H. Leaves stay green year around
I. Not compound
J. A leaf with two or more leaflets
K. Without teeth
L. Two leaves or stems at a node
M. Sawtoothed
N. A projecting portion of a leaf
O. An arrangement of leaves not whorled or opposite
P. Segments along each side of a common axis
Q. Arrangement of 3 or more structures at a single node
R. Foliar element or a compound leaf
S. First word in a Latin name
T. Second word in a Latin name

WORKSHEET

GARDEN FLOWER TERMINOLOGY

Matching

1. ___ Annual
2. ___ Basal
3. ___ Biennial
4. ___ Bulb
5. ___ Perennial
6. ___ Petal
7. ___ Pistil
8. ___ Pollen
9. ___ Sepal
10. ___ Stamen
11. ___ Inflorescence
12. ___ Herbaceous

A. Soft, not woody stems

B. Female flower part

C. Three or more seasons in the life cycle

D. A modified underground stem

E. One unit of a flower, usually colorful

F. Living and maturing in one season

G. Outer unit of a flower, usually green

H. Male part of flower

I. As in leaves attached at the base of the plant

J. Microspores borne on the stamen

K. Life cycle consisting of two years

L. Arrangement of flowers on an axis

JOB SHEET

TREE AND SHRUB IDENTIFICATION

I. Introduction:

The purpose of this exercise is to provide a means of recording tree and shrub identification characteristics.

II. Objective:

At the conclusion of this exercise, students will be able to correctly give common names to selected trees and shrubs by observing growth habits, twig, leaf, bark and fruit characteristics.

III. Procedure:

The teacher should select 15 of the 30 trees and 9 of the 15 shrubs on the worksheets to be taught in class. The first 15 trees listed and the first 9 shrubs are suggested species. Not all areas in Illinois have these species, so it may be necessary to make substitutions.

While looking at an actual tree or shrub, record it's distinguishing characteristics, along with the common name, next to the leaf drawing that best matches the plant.

Tree List

Page 22

Betula papyrifera	Paper Birch
Acer saccharinum	Silver Maple
Ulmus americana	American Elm

Page 23

Quercus alba	White Oak
Acer saccharum	Sugar Maple

Page 24

Platanus occidentalis	American Sycamore
Quercus palustris	Pin Oak

Page 25

Celtis occidentalis	Common Hackberry
Aesculus hippocastanum	Common Horsechestnut

Page 26

Tilia americana	American Linden
Gleditsia triancanthos	Common Honeylocust

Page 27

Tilia cordata	Littleleaf Linden
Liriodendron tulipifera	Tuliptree

Page 28

Malus sp.	Crabapple
Fraxinus pennsylvania	Green Ash

Page 29

Cercis canadensis	Eastern Redbud
Acer rubrum	Red Maple

Page 30

Liquidambar styraciflua	American Sweetgum
Quercus rubra	Northern Red Oak

Page 31

Populus deltoides	Eastern Cottonwood
Pyrus calleryana "Bradford"	Bradford Callery Pear
Ginkgo biloba	Ginkgo

Page 32

Catalpa speciosa	Northern Catalpa
Fraxinus americana	White Ash

Page 33

Sorbus aucuparia	European Mountainash
Salix alba	White Willow

Page 34

Acer platanoides	Norway Maple
Magnolia soulangiana	Saucer Magnolia

Page 35

Juglans nigra	Black Walnut
Fagus sylvatica	European Beech

Shrub List

Page 36

Berberis thunbergi	Japanese Barberry
Cotoneaster lucida	Hedge Cotoneaster
Cornus stolonifera	Redosier Dogwood

Page 37

Euonymus alatus "Compactus"	Dwarf Winged Euonymus
Forsythia sp.	Forsythia
Ligustrum amurense	Amur Privet

Page 38

Lonicera tatarica	Tatarian Honeysuckle
Potentilla fructicosa	Bush Cinquefoil
Ribes alpinum	Alpine Currant

Page 39

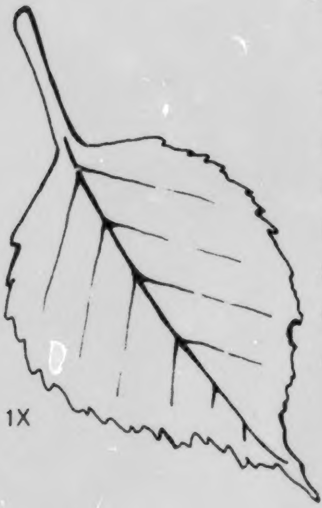
Spiraea prunifolia	Bridalwreath Spirea
Syringa vulgaris	Common Lilac
Viburnum carlesi	Koreanspice Viburnum

Page 40

Philadelpus coronarius	Sweet Mockorange
Chaenomeles speciosa	Common Floweringquince
Weigela florida	Old Fashioned Weigela

STUDENT WORKSHEET

TREE LEAVES



Tree Name:
Bark Characteristics:
Leaf Characteristics:
Fall Color:
Size:
Culture:
Additional Notes:

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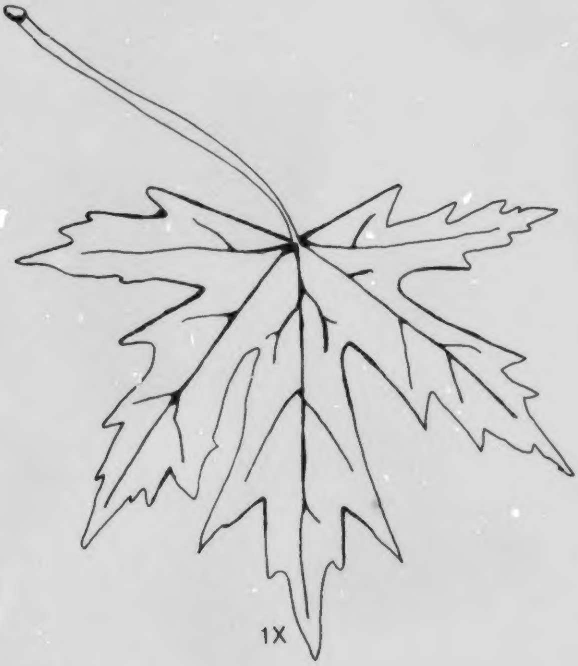

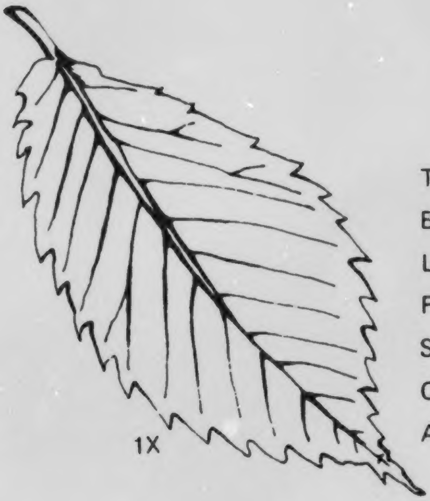

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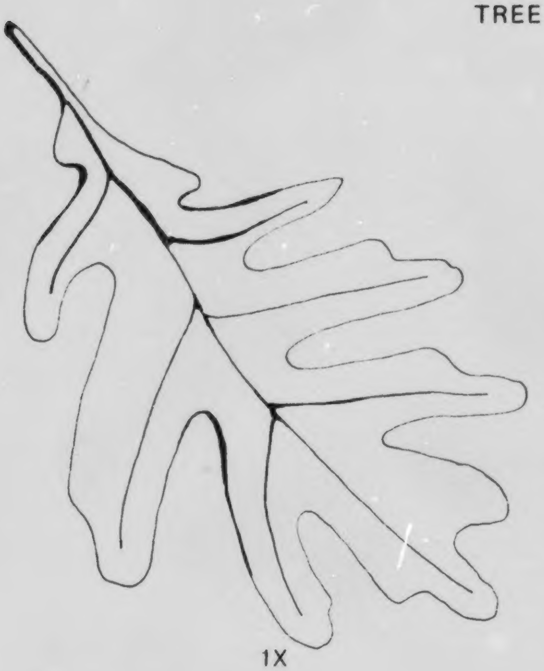
TREE LEAVES



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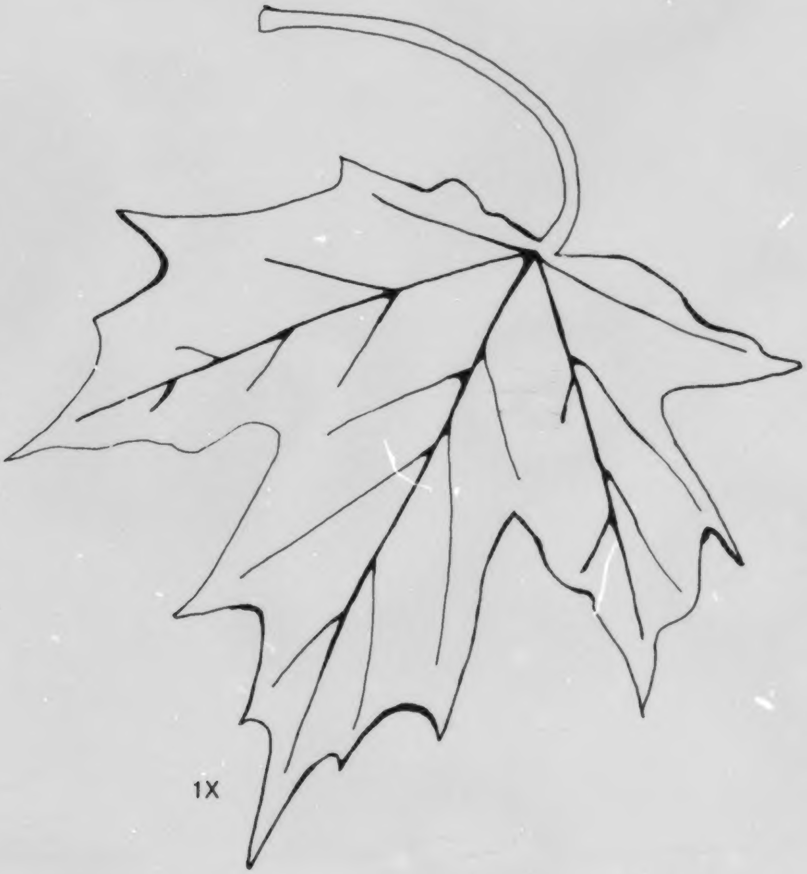

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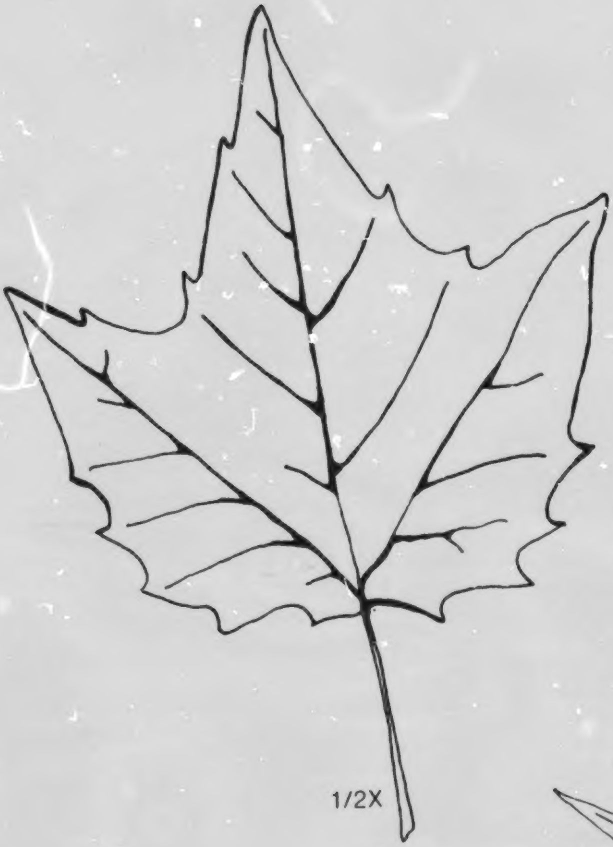

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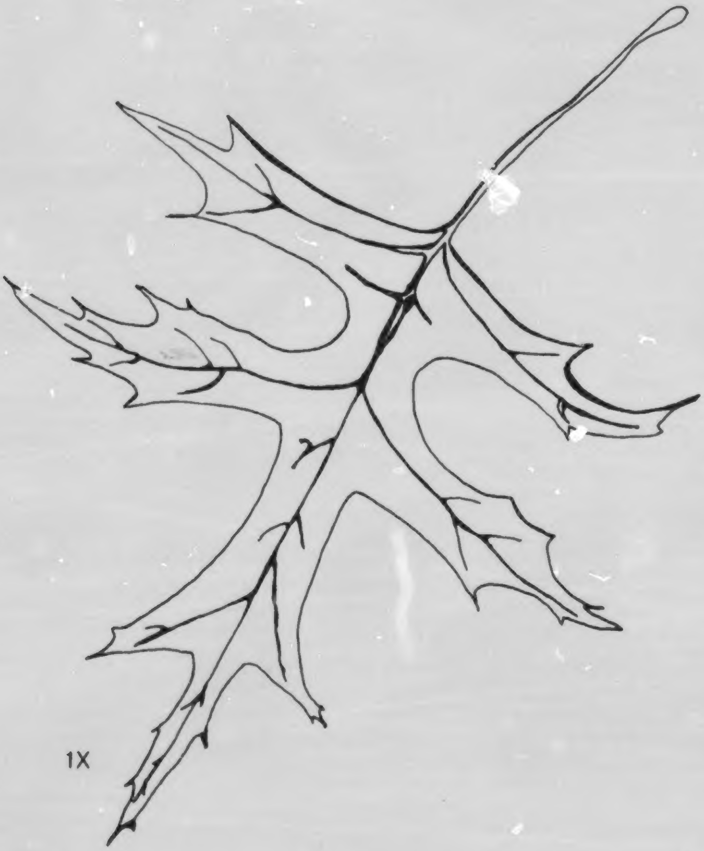

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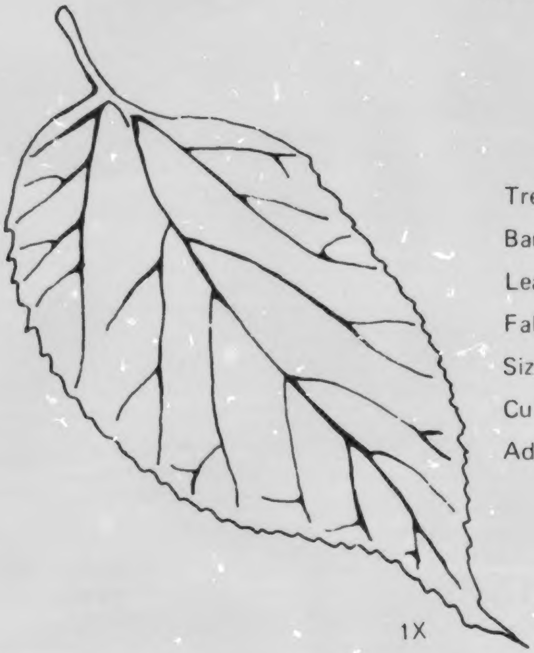
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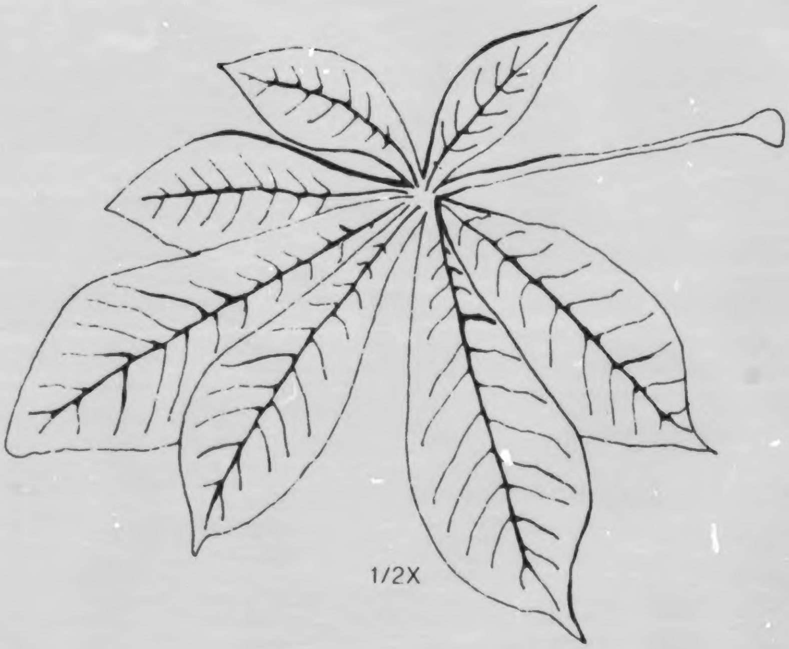
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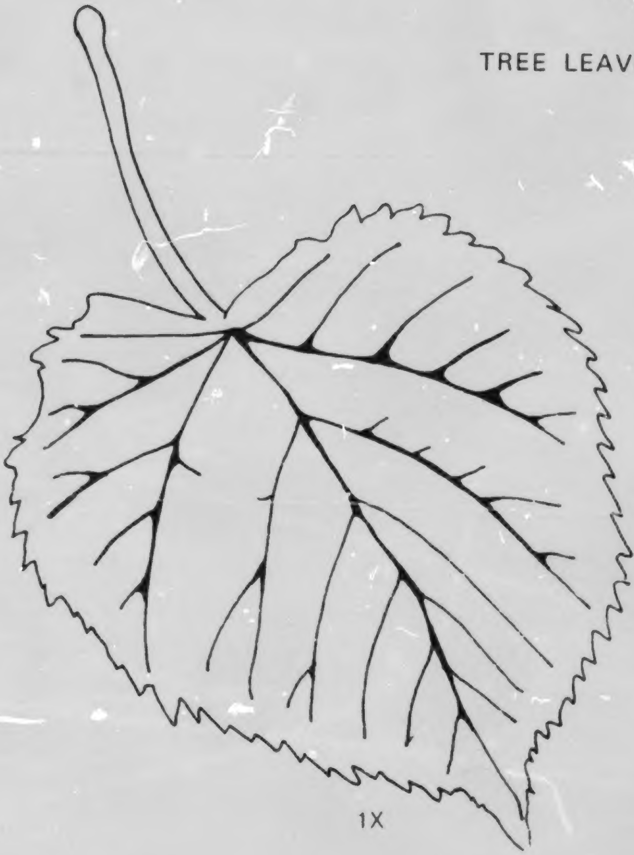
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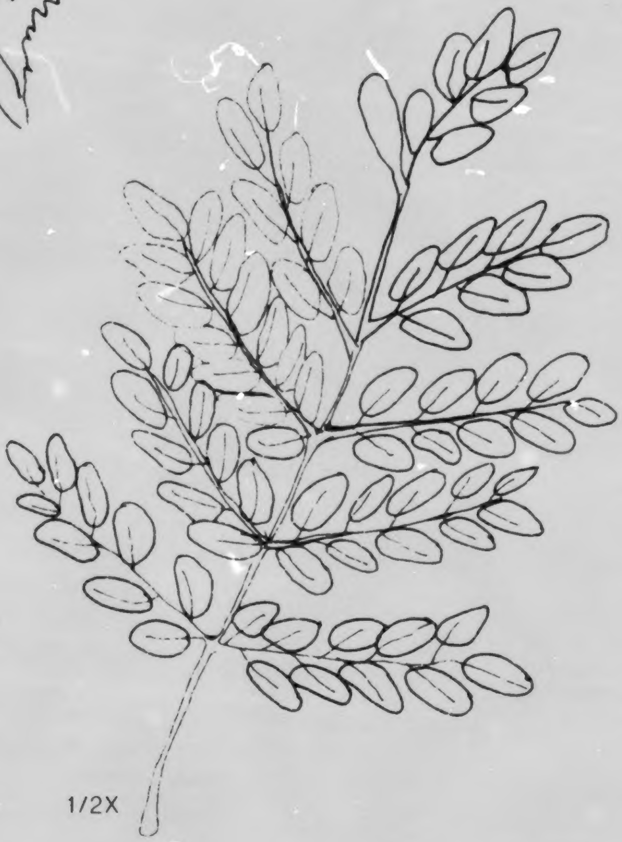
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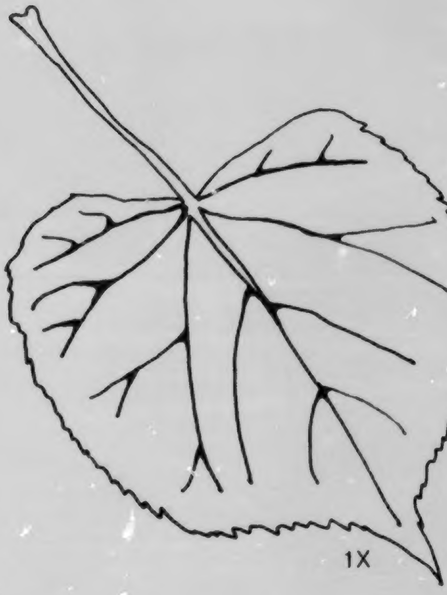
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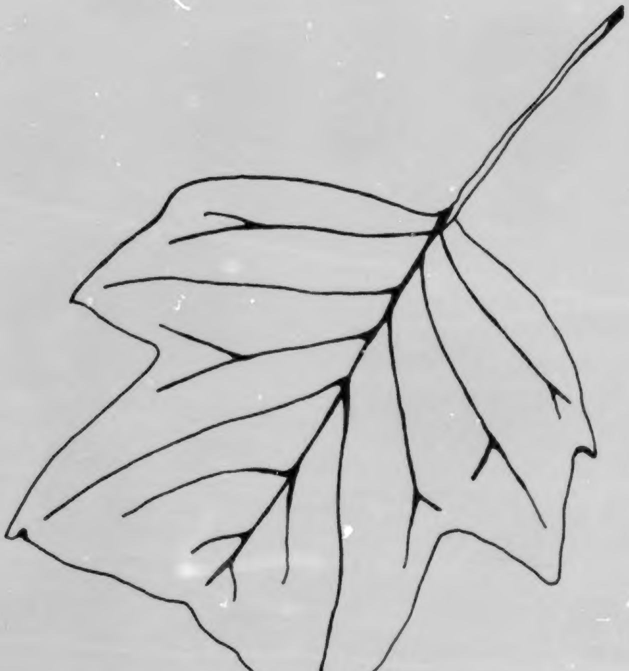
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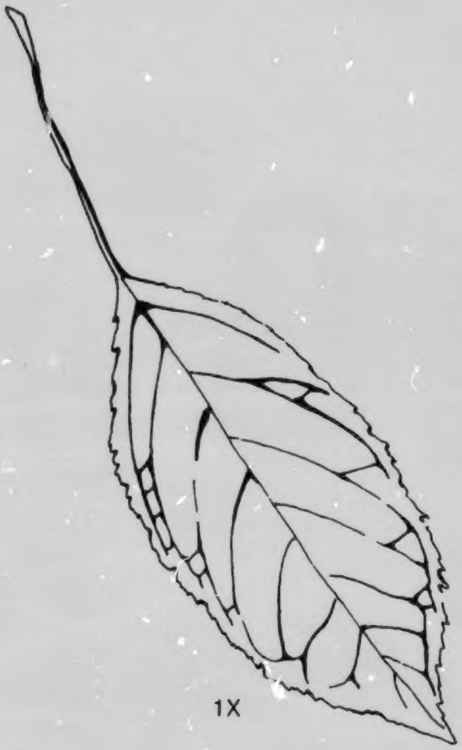

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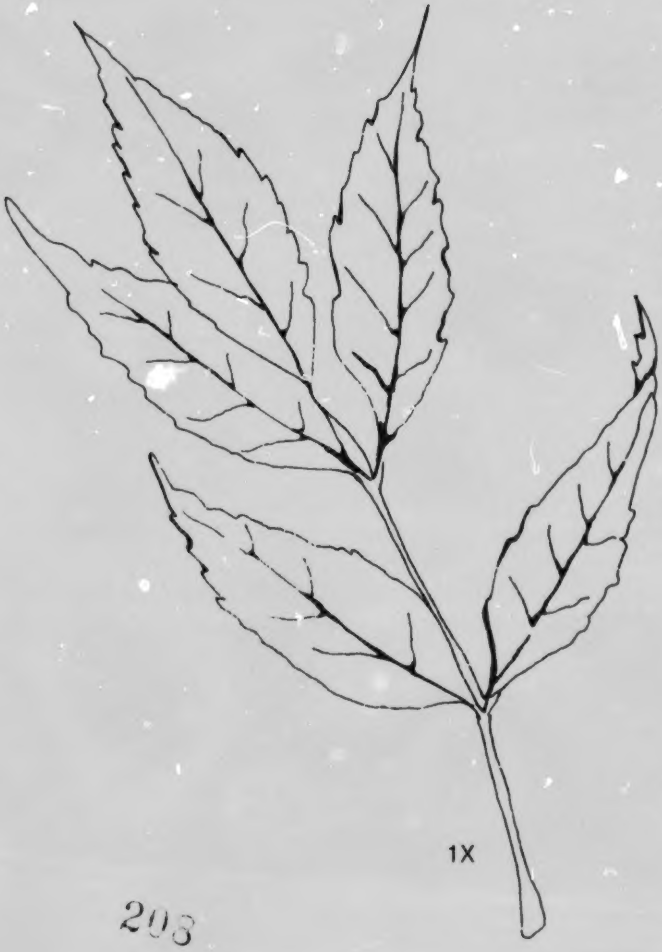

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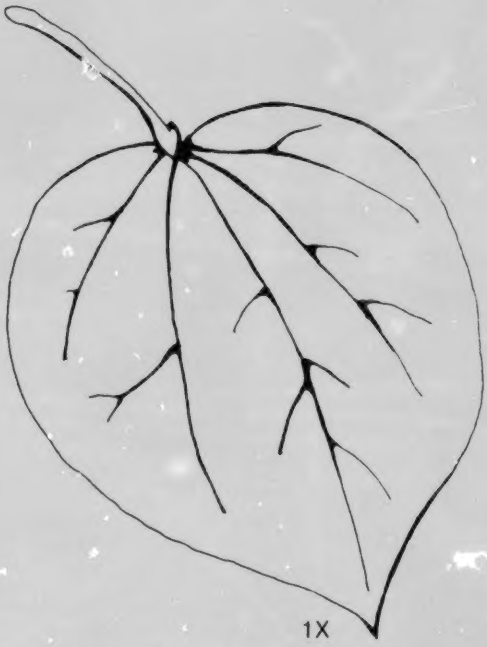
TREE LEAVES



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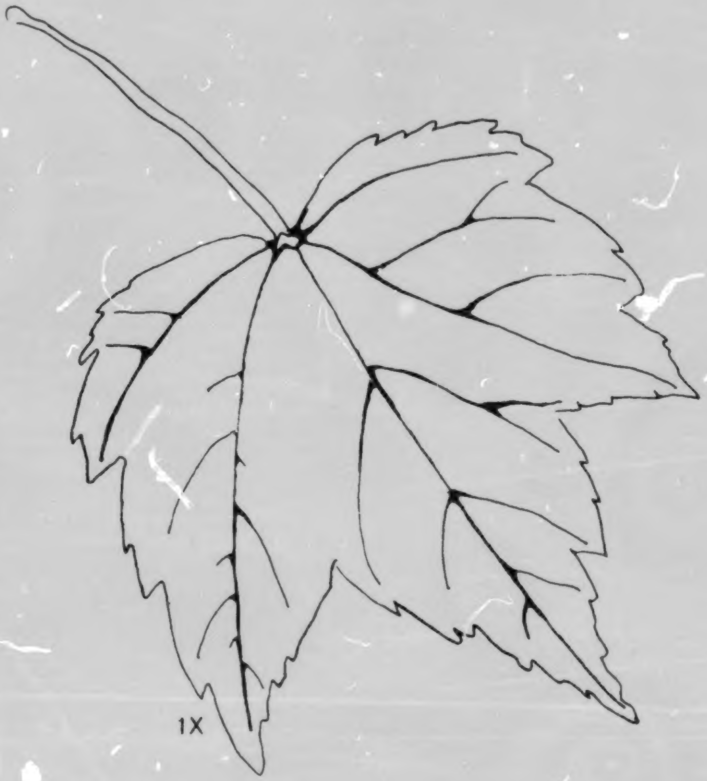

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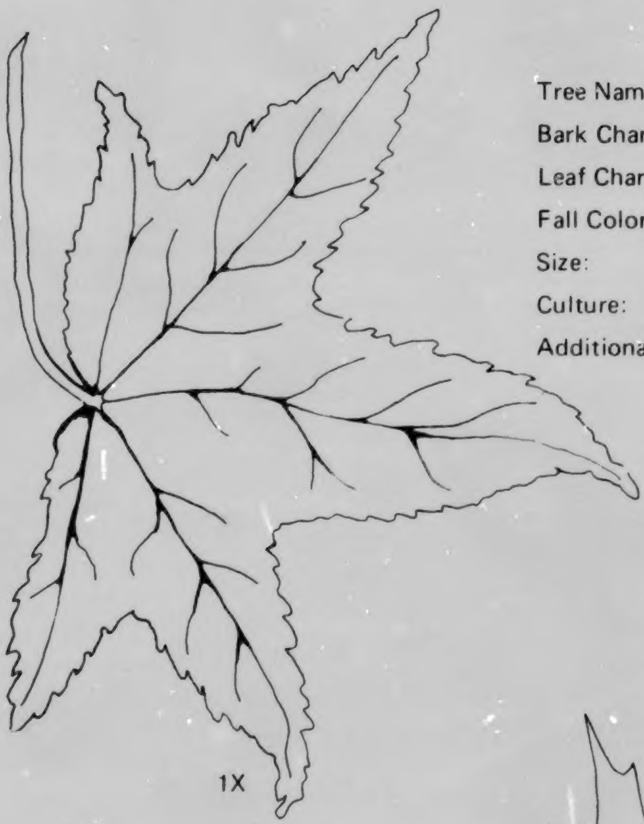

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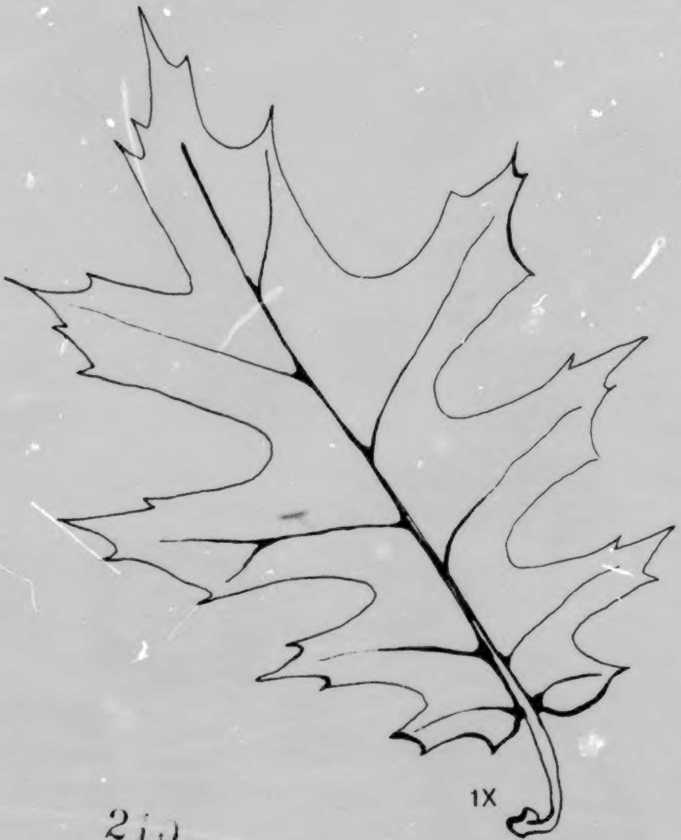

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TREE LEAVES

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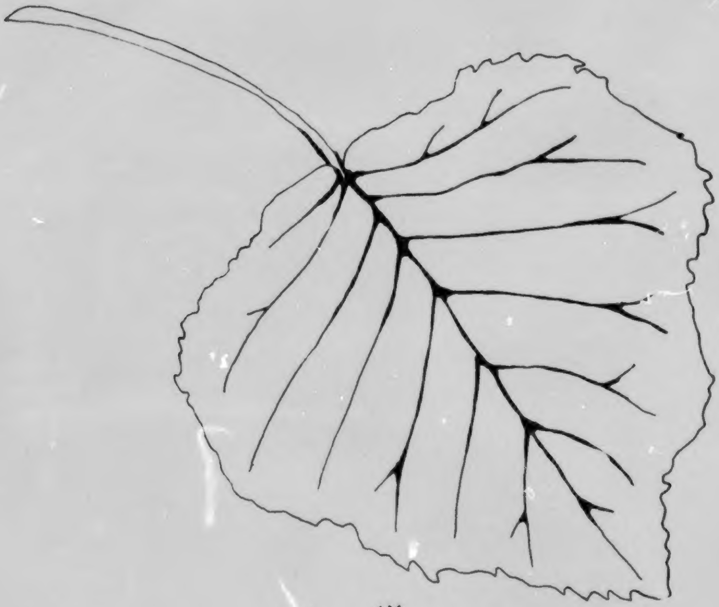

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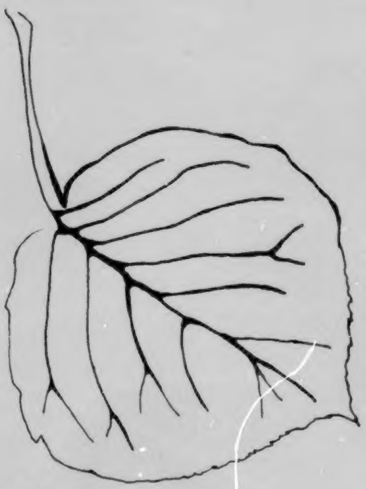

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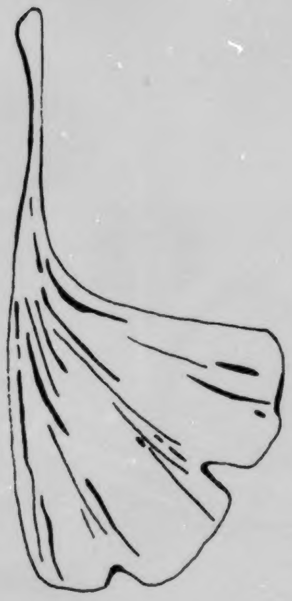

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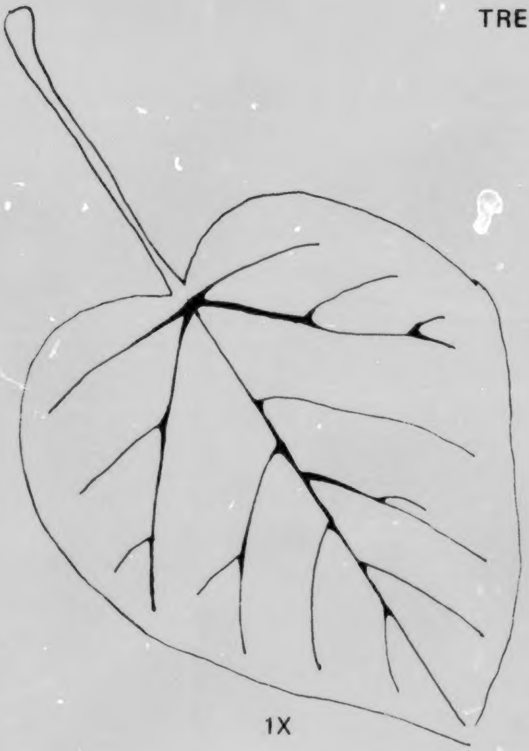
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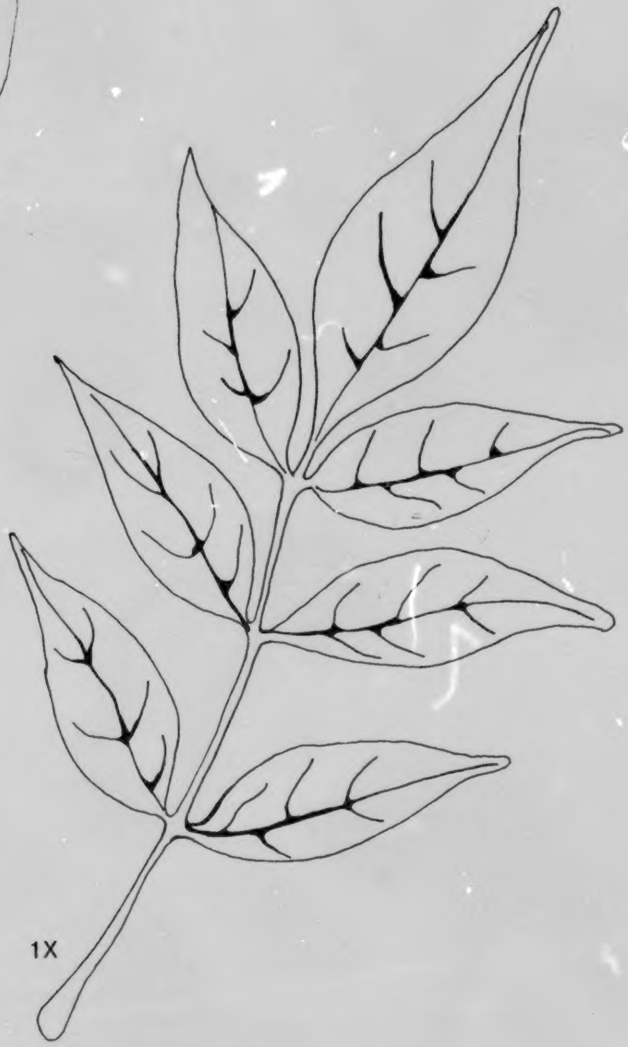
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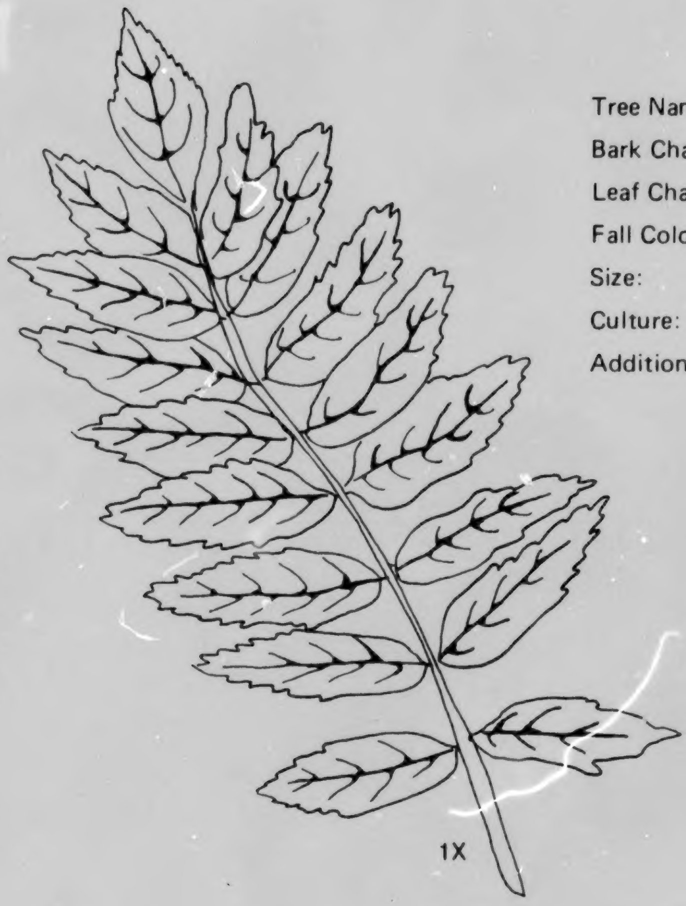

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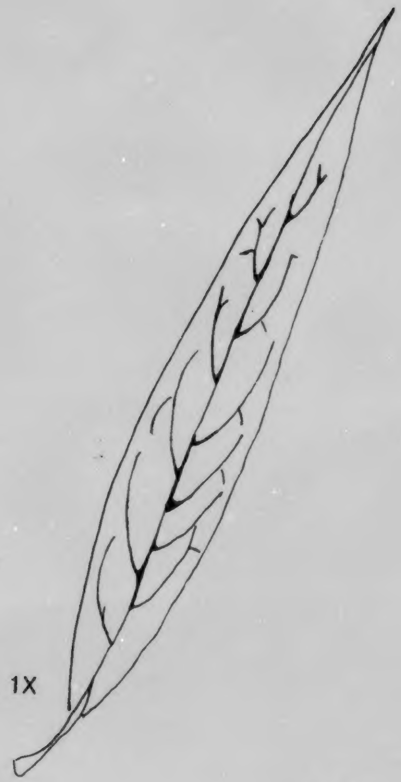

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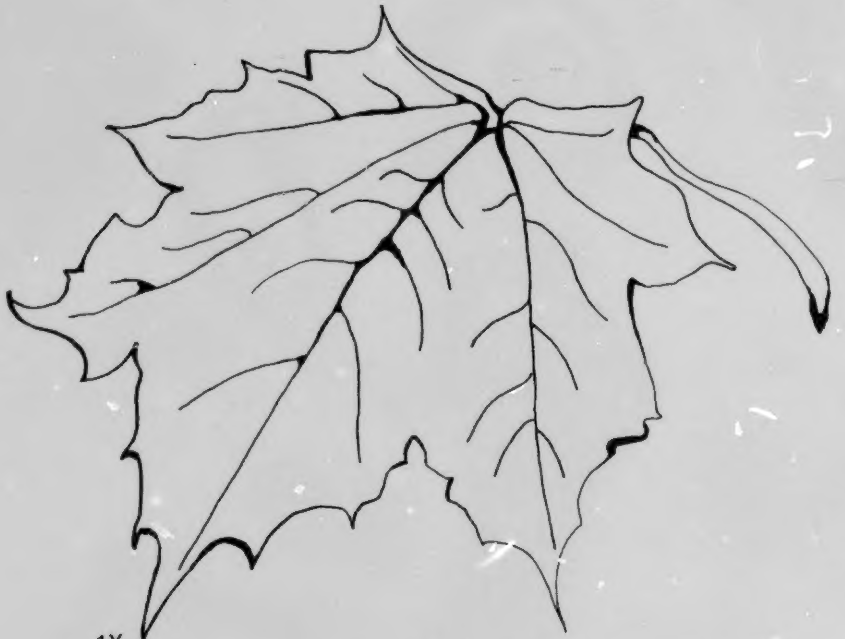

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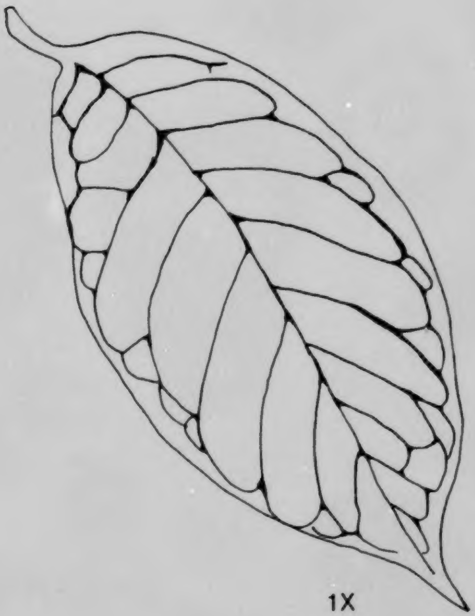

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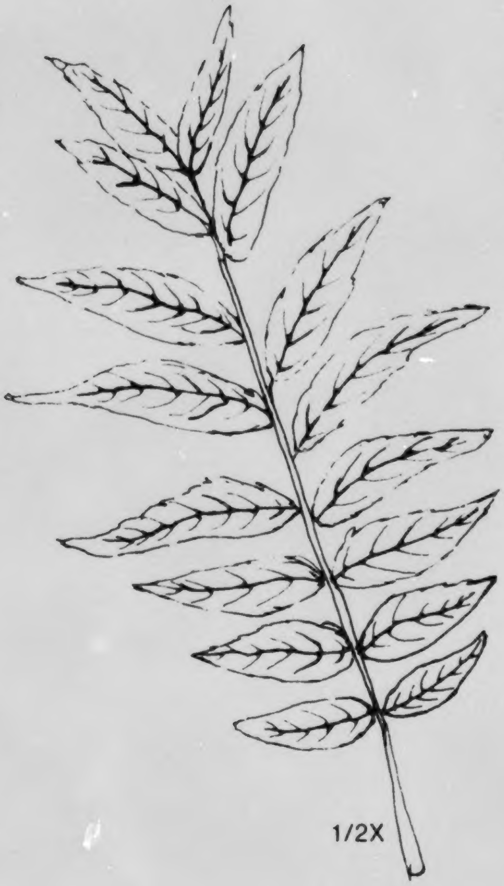
TREE LEAVES



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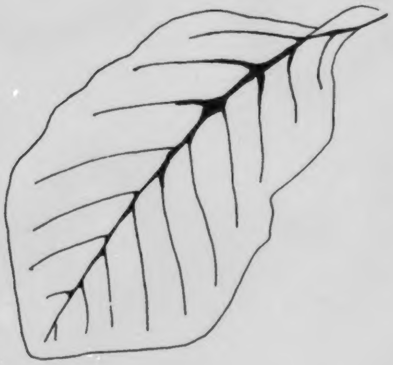

STUDENT WORKSHEET

SHRUB LEAVES

Shrub Name:
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Fall Color:
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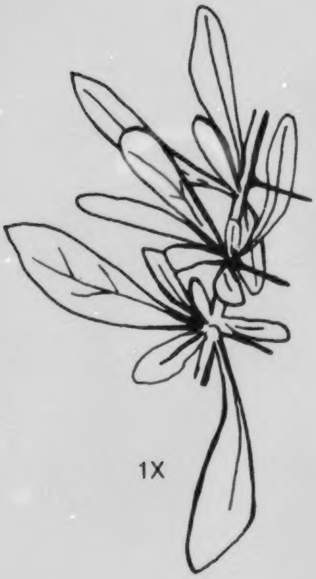

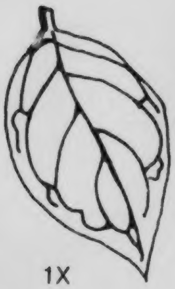

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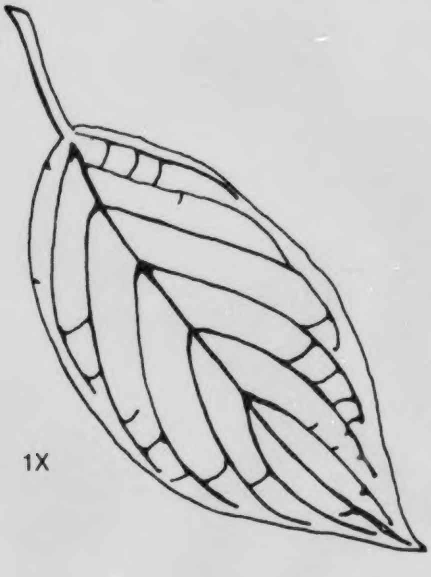

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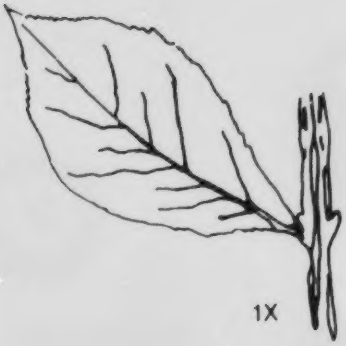

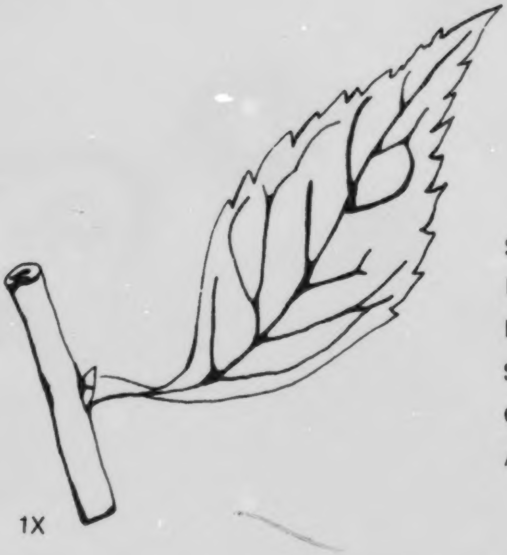

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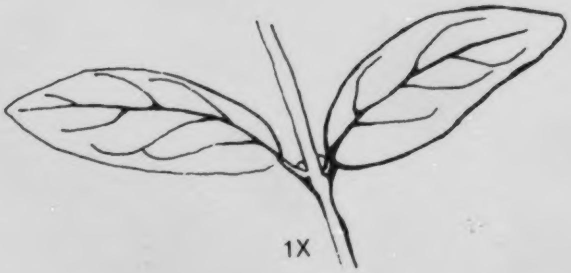

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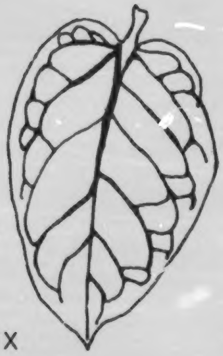

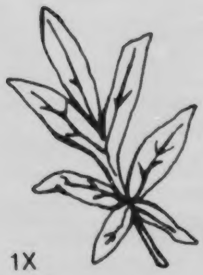

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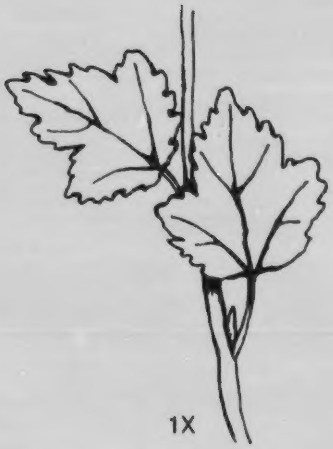

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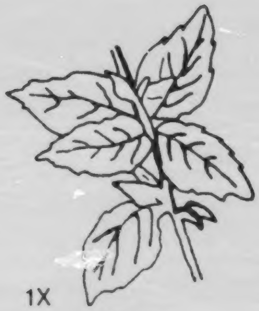

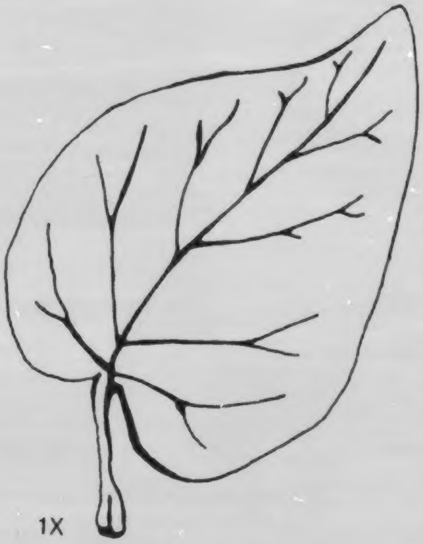

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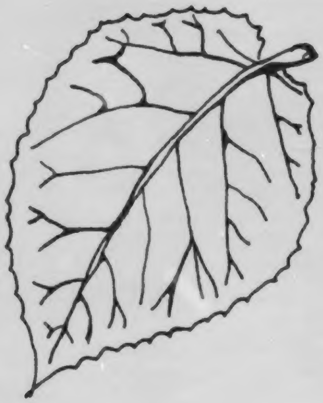
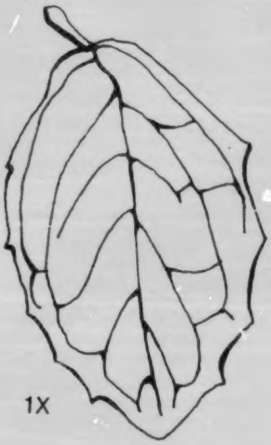
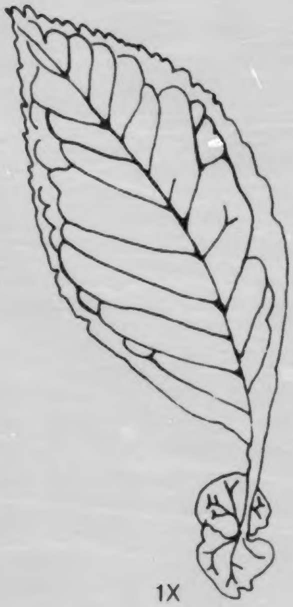
Culture:
Additional Notes:



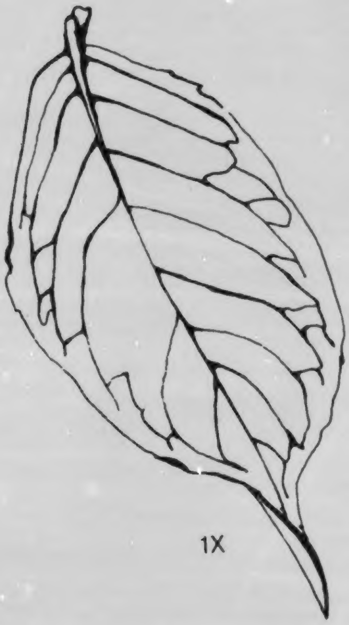
SHRUB LEAVES



Shrub Name:
Leaf Characteristics:
Fall Color:
Size:
Culture:
Additional Notes:



Shrub Name:
Leaf Characteristics:
Fall Color:
Size:
Culture:
Additional Notes:



Shrub Name:
Leaf Characteristics:
Fall Color:
Size:
Culture:
Additional Notes:

JOB SHEET

CONIFER IDENTIFICATION

I. Introduction:

The purpose of this exercise is to provide a means of organizing coniferous tree and shrub identification characteristics.

II. Objective:

Upon completion of this exercise, students will be able to identify by name selected coniferous trees and shrubs.

III. Procedure:

When observing a coniferous tree or shrub, record the identification features along with the common name.

Suggested Evergreens or Conifers

Pinus strobus	Eastern White Pine
Pinus sylvestris	Scotch Pine
Picea pungens "Glauca"	Blue Colorado Spruce
Picea abies	Norway Spruce
Pseudotsuga menziesii	Douglasfir
Abies balsamea	Balsam Fir
Juniperus virginiana	Eastern Redcedar
Juniperus chinensis "Pfitzeriana"	Pfitzer Chinese Juniper
Juniperus horizontalis "Plumosa"	Andorra Creeping Juniper
Taxus sp.	Yew
Thuja occidentalis	Eastern Arborvitae
Larix decidua	European Larch
Taxoduim distichum	Common Baldcypress

CONIFER IDENTIFICATION

PLANT NAME	LEAF CHARACTERISTICS	GROWTH HABIT AND SIZE	CONE	ADDITIONAL NOTES

JOB SHEET

SCAVENGER HUNT GUIDELINES

Purpose: This is an exercise in identifying various trees, shrubs, and conifers.

Procedure: Divide the class into groups of 3 - 4 students. Provide a list of materials to be collected by each group. The suggested time limit for the hunt is the time allotted for one period of classroom instruction.

The first group to gather the items and return to the class is the winner. Awards such as house plants or food may be offered to provide incentive.

Example list:

1	leaf of a Red Maple
1	palmately compound leaf of any kind
1	cone from a Norway Spruce
1	acorn from a White Oak
1	leaf of a Hackberry displaying Hackberry Nipple Gall
1	fascicle of a five needles
1	fruit structure from a Sweetgum

TEACHER'S KEY TO WORKSHEET

WOODY PLANT TERMINOLOGY

Matching

1. S Genus
2. O Altenate
3. C Deciduous
4. J Compound leaf
5. K Entire
6. T Species
7. B Fascicle
8. R Leaflet
9. N Lobe
10. A Node
11. G Cultivar
12. L Opposite
13. H Evergreen
14. D Palmate
15. E Petiole
16. I Simple leaf
17. Q Whorl
18. P Pinnate
19. M Serrate
20. F Sinus

A. The joint on a stem

B. Cluster, as with needles of pine

C. Loses leaves in the fall

D. Fan-like, from a common point

E. Leaf stalk

F. The space between two lobes

G. Variety

H. Leaves stay green year round

I. Not compound

J. A leaf with two or more leaflets

K. Without teeth

L. Two leaves or stems at a node

M. Sawtoothed

N. A projecting portion of a leaf

O. An arrangement of leaves not whorled or opposite

P. Segments along each side of a common axis

Q. Arrangement of 3 or more structures at a single node

R. Foliar element or a compound leaf

S First word in a Latin name

T. Second word in a Latin name

TEACHER'S KEY TO WORKSHEET

GARDEN FLOWER TERMINOLOGY

Matching

1.	F	Annual	A.	Soft, not woody stems
2.	I	Basal	B.	Female flower part
3.	K	Biennial	C.	Three or more seasons in the life cycle
4.	D	Bulb	D.	A modified underground stem
5.	C	Perennial	E.	One unit of a flower, usually colorful
6.	E	Petal	F.	Living and maturing in one season
7.	B	Pistil	G.	Outer unit of a flower, usually green
8.	J	Pollen	H.	Male part of flower
9.	G	Sepal	I.	As in leaves attached at the base of the plant
10.	H	Stamen	J.	Microspores borne on the stamen
11.	L	Inflorescence	K.	Life cycle consisting of two years
12.	A	Herbaceous	L.	Arrangement of flowers on an axis

TEACHER'S KEY

SAMPLE TEST QUESTIONS

IDENTIFYING TREES, SHRUBS, AND FLOWERS

Multiple Choice

D 1. Which of the following trees have opposite buds?

- A. Sugar Maple
- B. American Elm
- C. Green Ash
- D. Both A and C
- E. Both B and C

C 2. Which tree has compound leaves?

- A. Paper Birch
- B. Littleleaf Linden
- C. Horsechestnut
- D. American Sycamore

D 3. Which tree has distinctively ornamental bark?

- A. Hackberry
- B. Tuliptree
- C. Honeylocust
- D. Paper Birch

C 4. Which tree colors poorly in the fall?

- A. Ginkgo
- B. Paper Birch
- C. American Linden
- D. Sugar Maple

A 5. ________________ is an excellent barrier because of its small sharp thorns

- A. Japanese Barberry
- B. Lilac
- C. Alpine Currant
- D. Potentilla

B 6. Which shrub has alternate leaves?

- A. Dwarf Winged Euonymus
- B. Forsythia
- C. Koreanspice Viburnum
- D. Amur Privet

B 7. ________________ is an evergreen shrub displaying a seed encased in red fleshy material.

A. Pfitzer Juniper
B. Yew
C. Douglasfir
D. Arborvitae

C 8. This evergreen tree has orange bark.

A. Andorra Juniper
B. Norway Spruce
C. Scotch Pine
D. Eastern White Pine

D 9. ____________ has very colorful foliage.

A. Petunia
B. Sweet Alyssum
C. Snapdragon
D. Coleus

C 10. Which annual has blue flowers?

A. Zinnia
B. Impatiens
C. Ageratum
D. Celosia

A 11. Which perennial normally flowers in late summer or fall?

A. Hardy Chrysanthemum
B. Narcissus
C. Peony
D. Caladium

D 12. Which of the following can have yellow flowers?

A. Tulip
B. Daylily
C. Hosta Lily
D. Both A and B
E. All of the above

Fill in the blanks

1. Crabapples are small landscape trees which display attractive flowers in the spring and colorful fruits from late summer to winter.

2. A large tree having leaves with many rounded lobes and sinuses and bearing acorns is a White Oak .

3. A large shrub having red stems is a Redosier Dogwood .

4. A large coniferous tree with circular leaf scars and frequently used as a Christmas tree is Balsam Fir .

5. Moss Rose is a low growing, prolific seedling, fleshy leafed annual.

6. Canna Lily can grow up to 4-5 feet tall and bear bright yellow, orange or red flowers.

True (+) False (-)

+ 1. Pin Oaks have a strongly pyramidal growth habit.

+ 2. Witches brooms are commonly found on Hackberry.

- 3. Honeylocust has compound palmate leaves.

+ 4. Peking Cotoneaster is a large shrub with yellow to red fall color.

- 5. Potentilla has bright blue flowers borne in summer.

+ 6. Douglasfir bears distinctive cones in that the bracts extend beyond the scales.

+ 7. Eastern Redcedar is an evergreen tree with scale-like foliage.

- 8. Dusty Miller is grown for its shiny green foliage.

+ 9. Sweet Alyssum has a multitude of tiny white to violet flowers.

- 10. Iris have oval leaves.

UNIT G: HORTICULTURE

PROBLEM AREA: PROPAGATING PLANTS SEXUALLY AND ASEXUALLY

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade or second-year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is during the winter months. The estimated time for teaching this problem is area is 3 to 5 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. The students have had the equivalent of one year in an agricultural occupations program.
2. The students will have an opportunity to obtain "hands-on experience" in propagating plants.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts this problem area to his/her local situation.

CREDIT SOURCES:

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The teacher's guide, job sheets, transparency discussion guide, and test questions were developed by Jim Ethridge, Joliet Junior College, and Ron Biondo, Department of Vocational and Technical Education, University of Illinois.

Suggestions and guidance in the development of these materials were provided by Paul Hemp, Department of Vocational and Technical Education, University of Illinois and the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Horticulture

II. Problem area: Propagating plants sexually and asexually

III. Objectives: At the close of this problem area students will:

   1. Demonstrate skills in the propagation of seedlings in seed flats.
   2. Demonstrate familiarity with terminology pertaining to the propagation of seedlings.
   3. Develop an understanding of asexual propagation and terminology involved.
   4. Be able to prepare growing media for asexual propagation.
   5. Demonstrate correctly the techniques required in propagating plants by cuttings.
   6. Develop the ability to propagate selected plants through air layering.
   7. Propagate selected plants by division.

IV. Suggested interest approaches:

   1. Prepare a demonstration showing the proper methods of preparing a seed flat and tools used in preparing seed flats.
   2. Show slides on the different methods of taking cuttings and the proper procedure of each method.
   3. Demonstrate the taking of root cuttings using herbaceous plants which propagate readily. (i.e., horseradish).
   4. Demonstate different air layering techniques. Use Job Sheet #3, "Propagating by Air Layering".
   5. Display an aloe or sanseveria which are overcrowded; lead into a discussion on how to improve the situation.
   6. Ask the students to relate their experiences to any of the miscellaneous forms of propagating, what plants they used, and how they accomplished the propagation.

V. Anticipated problems and concerns:

   1. What care do seedlings need in the flat?
   2. What is viability?

3. What is a seed flat?

4. How do you fill a seed flat?

5. How should seeds be planted in a flat?

6. What characteristics do good growing media possess?

7. Why produce plants from cuttings?

8. What is a callus and how does it relate to rooting?

9. What are the characteristics of a good cutting?

10. What is a rooting hormone?

11. What is asexual plant propagation?

12. Which plant parts can be used for asexual propagation?

13. What are the procedures for making various cuttings?

14. What environmental conditions affect the rootings of cuttings?

15. What is the reason for air layering plants?

16. How should a plant be cared for after air layering?

17. Why are plants divided?

18. How are plants divided?

19. What are suckers? Runners? Stolons? Offshoots?

VI. Suggested learning activities and experiences:

1. Visit a grower and observe their plant propagating techniques and facilities.

2. Have students work out a propagation time schedule for a selected group of seeds.

3. Have the students complete Job Sheet #1 "Starting Seeds in Flats for Transplanting."

4. Plant specific seeds at different times and have students record results.

5. Have students read pages 17 to 19 of VAS Unit 5010a.

6. Have students read VAS Unit 5006 for basic information on asexual plant propagation. Follow this reading with a discussion.

7. Demonstrate to the students the correct procedure of making cuttings.

8. Have each student prepare plant cuttings using the steps and procedures described in Job Sheet #2 "Making Cuttings of Herbaceous Plants."

9. Show transparencies on how to handle herbaceous cuttings.

10. Visit a local propagating nursery and note how asexual propagation is practices.

11. Have the students prepare propagation media.

12. Show VAS Slidefilm 600 on Air Layering.

13. Have each student perform an air layering method of propagation following Job Sheet #3 "Propagation by Air Layering."

14. Show transparencices on the proper method of air layering.

15. Show transparencies on the various methods of propagation by division.

16. Have each student propagate plants using various methods of division. Utilize Job Sheet #4 "Asexual Propagation by Division."

17. Have each student select a plant from an approved list and discover through reading literature how the plant is commonly propagated; then, have each student demonstrate the method of propagation to the rest of the class.

VII. Application procedures:

1. The main purposes of this problem area are to teach information and develop student interests in proper seed germination in flats and asexual propagation.

2. The application phase should be emphasized in the school greenhouse or at home in growing bedding plants, vegetables, foliage plants, ground covers, and small fruits.

VIII. Evaluation:

1. Prepare and administer a written test using sample test questions.

2. Collect and grade student job sheets.

3. Evaluate performance on working with the various propagation techniques.

IX. References and aids:

1. Plant Propagation, Principles and Practices, Hartman and Kester. 3rd Edition, Prentice-Hall, Inc., Publishers.

2. Vocational Agriculture Service Units

   a. 5006 "Asexual Propagation" pp. 1,2,5,9,10,11
   b. 5010a "Growing Flowering Annuals" pp. 17-19

3. Vocational Agriculture Service Filmstrip

   a. #600 "Air Layering"

4. Student Job Sheets:

   a. "Starting Seeds in Flats for Transplanting"
   b. "Making Cuttings of Herbaceous Plants"
   c. "Propagating by Air Layering"
   d. "Asexual Propagation by Division"

5. Transparencies

6. Sample Test Questions and Teacher's Key

STUDENT WORKSHEET

ASEXUAL PROPAGATION

Directions: Use Vocational Agriculture Service Subject Matter Unit 5006A to Answer the Following Questions.

1. What is asexual propagation?

2. Why is asexual propagation important to the horticulture industry?

3. What are the six major categories of cuttings?

   a.
   b.
   c.
   d.
   e.
   f.

4. Which of the above is the most common?

5. Describe each of the following:

   a. Hardwood cuttings:

   b. Semihardwood cuttings:

   c. Softwood cuttings:

   d. Herbaceous cuttings:

   e. Leaf cuttings:

   f. Leaf-bud cuttings:

6. Define layerage:

7. What characteristics should a good rooting medium have?

8. Explain why it is important that cuttings be placed in the medium right side up.

JOB SHEET #1

STARTING SEEDS IN FLATS FOR TRANSPLANTING

I. Objective: To develop skills and knowledge in germinating seeds in growing flats.

II. Materials Needed:

- A. Flat (refer to Rural Core I, page I-H-4-12, for construction of a flat).
- B. Germination medium

  one third peat
  one third sand OR a soilless mix
  one third soil

- C. Packet of seeds (use tomato or annual flower seed)
- D. One 2" by 4" block that will fit inside of the flat
- E. Fungicide (a chemical that will kill fungus)

III. Procedure:

- A. Fill the flat within ½" of the top with the germinating medium.
- B. Firm lightly with a 2" X 4" block or brick.
- C. Make rows ¼" deep and 1½" apart in the germinating medium.
- D. Open the seed packet and put a small amount of fungicide in the packet with the seed. Close the opening and shake so all seeds will be coated with the fungicide.
- E. Sow the seeds in the medium. Cover lightly.
- F. Moisten and place in a warm place. You may cover the flat with glass, burlap or a plastic bag. (Instructor will decide). Check the flat several times and water as needed.
- G. Fill out label. (identify the seed, planting date, and sower).
- H. Apply fungicide. (read label).

IV. Observation:

JOB SHEET #2

MAKING CUTTINGS OF HERBACEOUS PLANTS

Note: Many ornamental plants can be propagated by cuttings taken from parent plants. A cutting is made by removing a vegetating part of the plant and treating it in such a way that roots will form and thus produce a new plant.

Three types of cuttings are commonly used when propagating plants. There are, however, many variations of these three types and the following demonstrations will provide a basic understanding of some of the various methods. The three common types of cuttings to be used for the demonstrations are:

a. stem cuttings

b. leaf cuttings

c. leaf petiole cuttings

It is recommended that a pressure mist system be installed for use with this demonstration and be kept as a permanent part of the plant growing facilities, if possible.

I. Objectives:

1. To develop the ability to propagate plants by making softwood cuttings of different types.
2. To develop an understanding of the practices to be used in propagating plants by means of cuttings.
3. To develop an understanding of the advantages of vegetative propagation by cuttings.

II. Materials Needed:

1. A supply of plants from which the various types of cuttings can be made. Some examples are:
    a. stem cuttings--carnation, coleus, geranium, ivy, chrysanthemum, begonia and philodendron.
    b. leaf cuttings--sansevieria or rex begonia.
    c. leaf petiole cuttings--african violet, gloxinia, tuberous begonia, and peperomia.
2. Rooting medium such as coarse sand, coarse sand and peat or vermiculite.

3. Material for shading cuttings such as cheesecloth.

4. Pots, growing bench, flats, plots for growing the cuttings.

III. Procedure:

1. Prepare the area in which the cuttings will be placed. This may involved preparing pots, a greenhouse bench, small area in the greenhouse, or preparing an outdoor plot near the school laboratory.

2. Select the plants to be propagated and determine the kinds of cuttings to be made. If possible, each student should make at least five cuttings of each of the three types. If materials are limited, students may be divided into groups with each group responsible for making a few cuttings of each type.

3. Make the cuttings as follows:

    a. For stem cuttings, select healthy, rapidly growing stems. Cut the stem in lengths approximately 3-4 inches long, making the basal cut just below a node.

    b. For leaf cuttings, select healthy leaves. Remove the leaves from the stem of the plant. The leaves should lay flat on the growing medium. They should be weighted or pinned to make sure that they will stay in this flattened position. Cut through the veins of the leaf at several different points.

    If sansevieria is used, the leaf must be chemically treated with a root inducing hormone and must be placed upright with the base of the leaf in the medium.

    c. For leaf petiole cuttings, remove a number of health leaves with their petioles. Places the petioles in the growing medium the same as you would a stem cutting.

4. Treat the cuttings with a root inducing hormone and stick them into the rooting medium. Be careful not to allow any of the hormone to get on the buds of the stem cuttings.

5. Keep the cuttings moist, but do not saturate the medium. Maintain an even temperature of about 70° F. and shade the plants from direct sunlight.

6. Keep a record of the results of the demonstration as follows, recognizing that details of the record will vary according to the material used and the facilities available:

- a. Kind of plant used.
- b. Kind of cutting made.
- c. Number of cuttings made.
- d. Kind of plant hormone(s) used.
- e. Kind of rooting medium used.
- f. Temperature at which the cuttings were held.
- g. Per cent of cuttings rooted.
- h. Time required for cuttings to produce one-half inch roots.
- i. Point or location on the cutting at which roots were produced.

IV. Application:

Production of plants from cuttings is a popular hobby for some people. For others who are interested in commerical production of plants, this method of propagation represents a highly desirable means of producing large number of plants, all of which will have the same characteristics. The fact that cuttings are made from vegetable parts of the plants ensures the producer that the propagated plants will have identical characteristics to those of the parent plant. This method of propagation also offers a means of reducing the amount of time normally required to to grow certain plants to maturity or to a salable size.

V. Observations:

JOB SHEET #3

PROPAGATION BY AIR LAYERING

I. Objective: To root a plant while it is still attached to the parent plant.

II. Materials:

1. Plant materials
2. Knife
3. Toothpicks
4. Rooting hormone powder
5. Plastic sheets (such as plastic sandwich bags)
6. 2 Twist ties
7. Moist sphaghnum moss
8. Plants - Dracaena, Rubber Plant, Dumb Cane (Differbachia)

III. Procedure:

1. Remove leaves from a 6" area of the Dracaena stem.

2. Make a slanted cut about halfway into the stem. Be careful not to cut entirely through the stem.

3. Prop the cut open, using toothpicks.

4. Place rooting hormone powder into the cut.

5. Wrap a handful of wet moss around the stem, making sure some wet moss gets into the cut area.

6. Wrap the moss with the plastic sheet. Be sure all air is removed from the wrapped area.

7. Tie a twist tie at both ends of the plastic sheet to secure the moss around the stem.

8. Place on the bench or area assigned.

9. When 3 roots are visible through the plastic, it is time to plant the air-layered cutting. Remove plastic. Cut through stem below the root mass. Transplant into a new pot. Water thoroughly. Keep out of direct sun until established.

10. The remaining portion of the original plant can be kept and will continue to put on new growth.

IV. Observations:

JOB SHEET #4

ASEXUAL PROPAGATION BY DIVISION

I. Objective: To propagate a plant by division.

II. Materials:

1. A multi-crowned plant,
2. knife,
3. extra pot
4. soil

III. Procedure:

1. Tap plant out of pot.
2. Using thumbs, pull apart the plant where it naturally splits apart.
3. Each new section should include a portion of leaf stem and root.
4. Repot new sections into pots.
5. Observe carefully.

IV. Discussion:

1. How many new plants resulted from the plant you divided?

2. Where is the crown of the plant located?

3. Name three (3) examples of multi-crowned plants.

4. If after dividing a plant, a section does not have any roots, what can be done to help save that particular section?

TEACHER'S KEY TO STUDENT WORKSHEET

ASEXUAL PROPAGATION

Directions: Use Vocational Agriculture Service Subject Matter Unit 5006A to Answer the Following Questions.

1. What is asexual propagation?

   Asexual propagation is the producing of new plants from vegetative parts of a parent plant.

2. Why is asexual propagation important to the horticulture industry?

   Asexual propagation is a rapid, inexpensive way to multiply a desirable plant form or cultivar. The newly produced plants will have the same characteristics as the parent plant.

3. What are the six major categories of cuttings?

   a. stem cuttings
   b. leaf cuttings
   c. leaf-bud cuttings
   d. root cuttings
   e. cuttings of specialized plant structures
   f. layerage

4. Which of the above is the most common?

   Stem cuttings

5. Describe each of the following:

   a. Hardwood cuttings:

      Taken in the fall; 4 to 12 inches long, including at least nodes; about pencil size.

   b. Semihardwood cuttings:

      Usually taken after a flush of growth in which the wood is only partially matured; 3 to 6 inches in length with the upper leaves left on; common with broad-leaved evergreens.

   c. Softwood cuttings:

      From succulent, new spring growth, somewhat flexible, but mature enough to break when bent sharply; 3 to 5 inches long, including two or more nodes.

d. Herbaceous cuttings:

Terminal cuttings from herbaceous plants, 2 to 5 inches long, with two or more nodes.

e. Leaf cuttings:

These are from part of a leaf blade, the entire leaf blade, or the leaf blade plus the petiole; generally herbaceous plants.

f. Leaf-bud cuttings:

Consists of leaf blade, petiole, and bud.

6. Define layerage:

Layerage is a propagation technique whereby a new plant is formed while still attached to the parent plant. The rooted, or layered, stem is then detached to become an independent plant growing on its own roots.

7. What characteristics should a good rooting medium have?

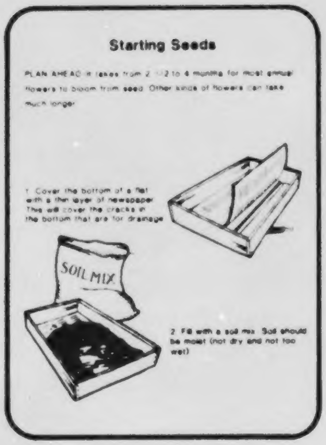
A good rooting medium should be capable of holding the cuttings in place during rooting, should retain water well enough that watering does not have to be frequent. It should provide adequate drainage and aeration, and should be free of undesirable organisms such as disease-causing fungi and bacteria, weed seeds, nematodes, and harmful insects.

8. Explain why it is important that cuttings be placed in the medium right side up.

Plant-manufactured food travels only in a downward direction and is necessary to produce roots. An upside down cutting will not have foods traveling in the right direction.

TRANSPARENCY DISCUSSION GUIDE

PLANT PROPAGATION



Starting Seeds

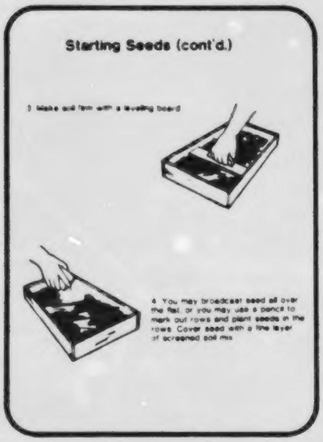
PLAN AHEAD it takes from 2 1/2 to 4 months for most annual flowers to bloom from seed. Other kinds of flowers can take much longer

1. Cover the bottom of a flat with a thin layer of newspaper. This will cover the cracks in the bottom that are for drainage

2. Fill with a soil mix. Soil should be moist (not dry and not too wet)

It takes from two and one-half to four months for most annual flowers to bloom from seed. When using a wood flat, cover the bottom of the flat with a layer of newspaper. This prevents fine soil from dropping through the seed flat.

Seeds of different species will require different soil mixes; fill the flat with a moist soil mix appropriate for the type of seed to be planted. The soil mix should be about one-half inch from the top of the flat when full.



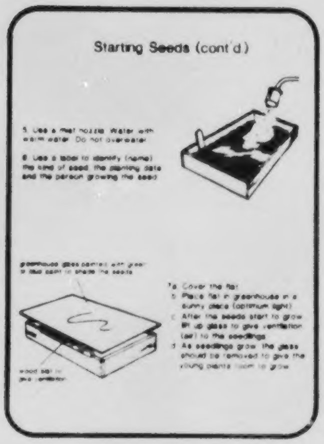
Starting Seeds (cont'd.)

3. Make soil firm with a leveling board

4. You may broadcast seed all over the flat, or you may use a pencil to mark out rows and plant seeds in the rows. Cover seed with a fine layer of screened soil mix

The soil should be made firm, using a one-half inch leveling board. Each flat size will determine the length of the board used for leveling. Make sure the soil level is the proper height.

Seed may either be broadcast over the surface, or planted in rows. Row planting is usually preferred over broadcast seeding because it reduces the spread of disease in the flat. An average seed flat with average-size seeds should contain approximately 500 seedlings at transplanting time. Determine the germination percentage from the seed package and calculate how many seeds to plant for the number of seedlings desired.



Starting Seeds (cont'd.)

5. Use a mist nozzle. Water with warm water. Do not overwater.

6. Use a label to identify (name) the kind of seed, the planting date and the person growing the seed.

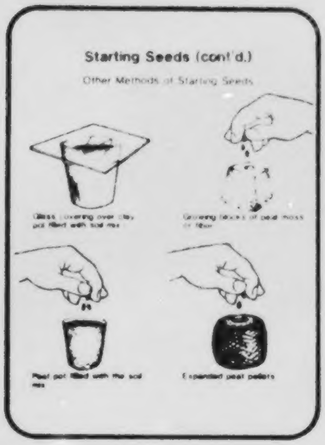
7a. Cover the flat.
b. Place flat in greenhouse in a sunny place (optimum light).
c. After the seeds start to grow lift up glass to give ventilation (air) to the seedlings.
d. As seedlings grow the glass should be removed to give the young plants room to grow.

greenhouse glass painted with glass or lime paint to shade the seeds
wood slat to give ventilation

When watering newly planted seeds, use a mist nozzle. Make sure the soil is evenly moist and not soggy. The temperature of the water can be a few degrees warmer than the air temperature. Using cold water may inhibit growth and development.

Use a plant label to identify the seed, planting date, and person planting the seed. Identifying the propagator is not common in a commercial business, but allows students to identify accomplishments and compare results with other students.

If the location selected in the greenhouse is too cool or drafty for the species planted, cover the flat with a sheet of glass or thin film of plastic. Allow for ventilation by placing wood slats between the flat and the chosen covering. The wood slats provide ventilation but not excessive draft, and the covering increases air temperature and decreased evaporation. This can be considered a minigreenhouse. This method is recommended whenever growing conditions are not the most favorable in an existing structure.



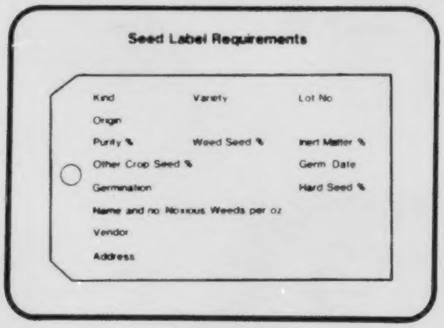
Starting Seeds (cont'd.)

Other Methods of Starting Seeds

Glass covering over clay pot filled with soil mix
Growing blocks of peat moss or fiber
Peat pot filled with the soil mix
Expanded peat pellets

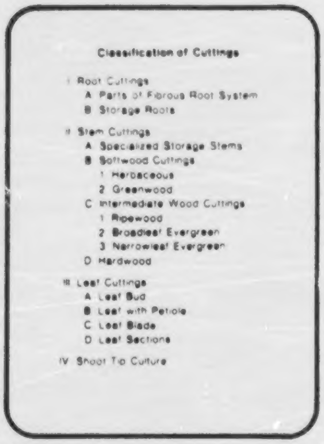
Other methods of planting seeds include planting seeds in a pot, planting seeds in peat moss blocks or fiber blocks, planting in peat pots, and planting in peat pellets. These seedling containers allow for constant growth without transplanting. Choosing one of these containers as an alternative to planting in flats is determined by quality or quantity desired, cost of the container, and salability. Commercial producers, as well as homeowners, use these alternatives for special crops, special markets, or due to preference. Usually the container is overseeded and then thinned down to one seedling per container.

A seed label should provide the information presented on this transparency. Note the percentage listings. They may represent percent by weight, volume, or number of seed. Other crop seed may be identified individually as well as by percentage.



Seed Label Requirements

Kind Variety Lot No
Origin
Purity % Weed Seed % Inert Matter %
Other Crop Seed % Germ Date
Germination Hard Seed %
Name and no Noxious Weeds per oz
Vendor
Address



Classification of Cuttings

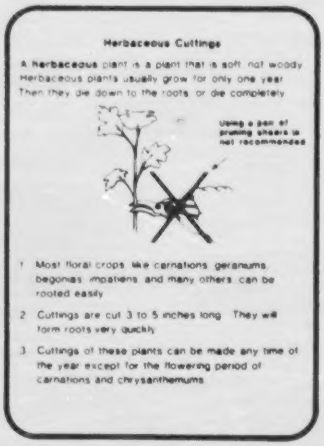
I Root Cuttings
  A Parts of Fibrous Root System
  B Storage Roots

II Stem Cuttings
  A Specialized Storage Stems
  B Softwood Cuttings
    1 Herbaceous
    2 Greenwood
  C Intermediate Wood Cuttings
    1 Ripewood
    2 Broadleaf Evergreen
    3 Narrowleaf Evergreen
  D Hardwood

III Leaf Cuttings
  A Leaf Bud
  B Leaf with Petiole
  C Leaf Blade
  D Leaf Sections

IV Shoot Tip Culture

Cuttings are made from vegetative portions of the plant. Cuttings can be classified according to the part of the plant from which they are obtained. A ripewood cutting is more commonly referred to as a semi-hardwood cutting. A leaf bud cutting may also be referred to as a stem cutting because it is a leaf and a bud with a portion of stem.



Herbaceous Cuttings

A **herbaceous** plant is a plant that is soft not woody Herbaceous plants usually grow for only one year Then they die down to the roots or die completely

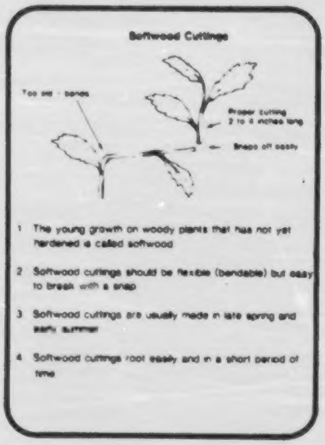
Using a pair of pruning shears is not recommended

1 Most floral crops like carnations geraniums begonias impatiens and many others can be rooted easily

2 Cuttings are cut 3 to 5 inches long They will form roots very quickly

3 Cuttings of these plants can be made any time of the year except for the flowering period of carnations and chrysanthemums

Herbaceous cuttings are the most common type of cuttings taken from house plants. These cuttings are the least expensive and easiest to propagate. The herbaceous cutting is usually "snapped-off" the plant, or cut off with a sharp knife. Using pruning shears is not recommended.



Softwood Cuttings

Too old - bends
Proper cutting 2 to 4 inches long
Snaps off easily

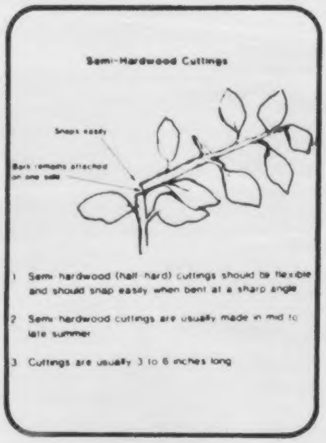
1 The young growth on woody plants that has not yet hardened is called softwood

2 Softwood cuttings should be flexible (bendable) but easy to break with a snap

3 Softwood cuttings are usually made in late spring and early summer

4 Softwood cuttings root easily and in a short period of time

The softwood cutting is taken from young growth of woody plants with the leaves attached. Fast-growing material with large internodes is undesirable. Softwood cuttings are generally taken early in the day before they dry excessively.

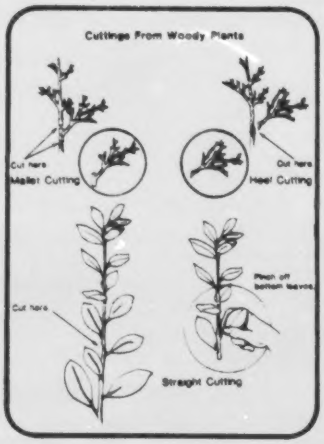

Semi-Hardwood Cuttings
Snaps easily
Bark remains attached on one side

1 Semi hardwood (half hard) cuttings should be flexible and should snap easily when bent at a sharp angle

2 Semi hardwood cuttings are usually made in mid to late summer

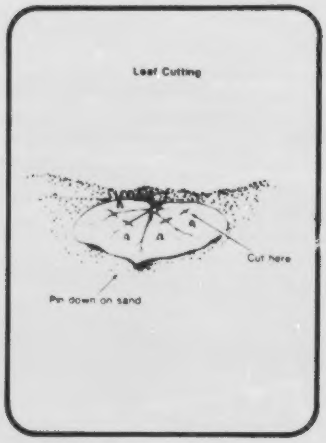
3 Cuttings are usually 3 to 6 inches long

Semi-hardwood or ripewood cuttings are commonly taken in late spring or early summer when new growth has matured sufficiently to snap easily when bent. Leaf size is usually reduced to lower the water loss and allow for a closer spacing of cuttings in the propagation bench. Most semi-hardwood cuttings must be misted if they are to survive.

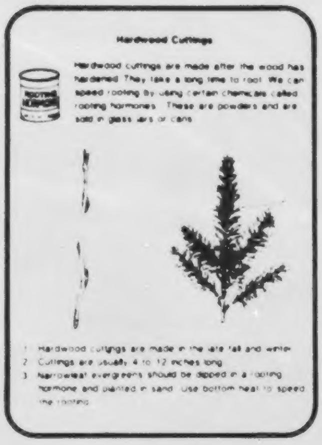

Cuttings From Woody Plants
Cut here
Mallet Cutting
Cut here
Heel Cutting
Cut here
Pinch off bottom leaves
Straight Cutting

Three types of cuttings are usually taken from woody plants. They are the mallet, the heel, and the straight cutting. The ease of rooting the species will determine what cutting is taken. With difficult to root species, more mature wood is often taken with the cutting.

Mallet cuttings include a short section of the stem of older wood. The heel cutting includes a small piece of older wood. The straight cutting is taken from the current season's growth.


Leaf Cutting
Cut here
Pin down on sand

With leaf cuttings, adventitious roots and adventitious shoots develop at a vein or at the base of the leaf. The original leaf or part of the leaf does not become part of a new plant. Plants usually propagated in the illustrated manner include begonia, gloxinia, and streptocarpus.



Hardwood Cuttings

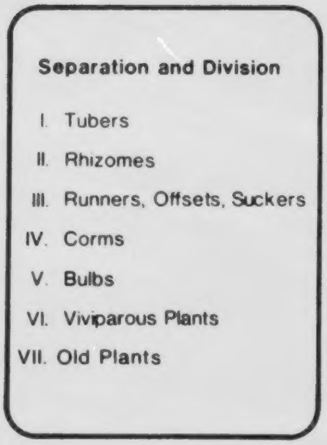
Hardwood cuttings are made after the wood has hardened. They take a long time to root. We can speed rooting by using certain chemicals called rooting hormones. These are powders and are sold in glass jars or cans.

1. Hardwood cuttings are made in the late fall and winter.
2. Cuttings are usually 4 to 12 inches long.
3. Narrowleaf evergreens should be dipped in a rooting hormone and planted in sand. Use bottom heat to speed the rooting.

Hardwood cuttings are commonly taken on deciduous plants and evergreen plants. The hardwood cutting is taken on the current season's wood after the plant has gone dormant and after the deciduous plant has lost its leaves. Evergreen cuttings require high light intensity, light misting, and bottom heat of 75^o to 80^o F. Dipping the cuttings in a fungicide helps to prevent disease.

Hardwood cuttings of average diameter and internode length for the species are the most desirable. The growing tip of the stem is usually low in stored food and should be discarded or propagated separately.

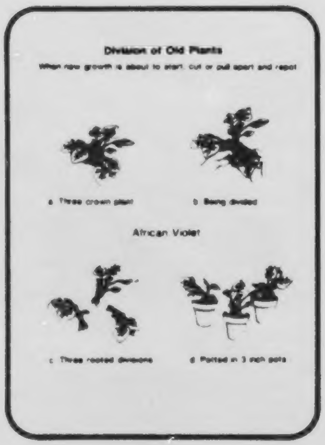
The purpose of a growth regulator is to increase the percentage of cuttings which form roots, to increase uniformity of rooting, and to increase the quality of roots that do form.



Separation and Division

I. Tubers
II. Rhizomes
III. Runners, Offsets, Suckers
IV. Corms
V. Bulbs
VI. Viviparous Plants
VII. Old Plants

Specialized stems and leaves require specialized methods of propagation rather than cuttings. This transparency identifies the most common vegetative means of reproducing plants. Vivipary refers to seeds which germinate while still attached to the plant.



Division of Old Plants

When new growth is about to start, cut or pull apart and repot

a. Three crown plant

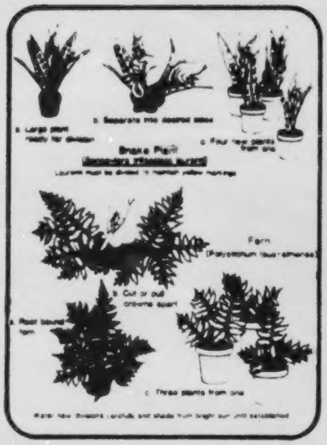
b. Being divided

African Violet

c. Three rooted divisions

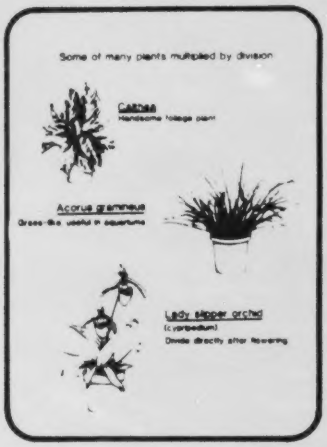
d. Potted in 3 inch pots

The African violet develops more than one crown as it matures. Splitting the crown and repotting result in several new plants in addition to the mother plant.

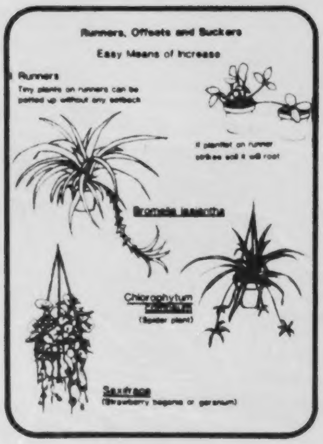

a. Large plant ready for division
b. Separate into desired sizes
c. Four new plants from one
Snake Plant
Fern
a. Root bound fern
b. Cut or pull crowns apart
c. Three plants from one
Water new divisions carefully and shade from bright sun until established

The *Sansevieria* develops new underground shoots from underground stems. The variegated varieties can only be maintained by separating the plants, not by means of leaf cuttings.

Many ferns produce new plants from underground stems or stems that grow on the soil surface. Cutting and separating the stems from the mature plant yield new plants. Pruning the plants helps to develop symmetrical plants.


Some of many plants multiplied by division
Calathea
Handsome foliage plant
Acorus gramineus
Grass-like, useful in aquariums
Lady slipper orchid
(cypripedium)
Divide directly after flowering

Calathea, *Acorus*, and *Cypripedium*, and many other plants can be propagated by dividing the mature plant. Division is also the common way of propagating peony, iris, and daylily.


Runners, Offsets and Suckers
Easy Means of Increase
a Runners
Tiny plants on runners can be potted up without any setback
If plantlet on runner strikes soil it will root
Chlorophytum
(Spider plant)
Saxifraga
(Strawberry begonia or geranium)

Runners, offsets, and suckers are specialized plant stems that produce small plantlets at some location of the stem.

Runners are above ground stolons produced by strawberries, strawberry begonias, and spider plants. The runner produces a plant that roots when placed in contact with the soil. These plants are commonly referred to as offsets.

TEACHER'S KEY

SAMPLE TEST QUESTIONS

PROPAGATING PLANTS SEXUALLY AND ASEXUALLY

True (+)-False (0)

0 1. It is not necessary to sterilize the benches, tools or media when propagating plants.

+ 2. Seeds sown too deep may not germinate.

+ 3. The depth a seed is planted depends upon the size of the seed.

+ 4. Labels should be used with freshly sown seed to avoid confusion.

0 5. It is not necessary to treat seeds with fungicide before sowing since those bought in packets are sterile.

+ 6. Stem cuttings should be 3 to 5 inches long.

+ 7. Air layering is the most common method of asexual propagation.

+ 8. Plants can be produced more quickly with stem cuttings than leaf cuttings.

0 9. Runners, offsets and suckers are difficult to start once removed from the mother plant.

+ 10. Asexual propagation insures the continuation of traits exhibited by the mother plant.

Multiple Choice

A 1. The leaves of herbaceous cuttings should be reduced in number to:

A. Reduce water loss and economize bench space.
B. Force growth of roots.
C. Reduce possibility of disease on leaves.
D. Aid in fertilizer and water application.

D 2. The proper time to transplant seedlings is when:

A. Seed leaves emerge.
B. They are full-grown.
C. The plant is 12 inches.
D. The first true leaves appear between the seed leaves.

C 3. When sowing seeds, the depth to plant them is equal to:

A. Diameter of seed
B. The depth of the media
C. 3 times the diameter of the seed
D. 1 inch

B 4. When air layering, the stem is cut to:

A. Make it easier to remove when rooted
B. Induce root information
C. Help hold the sphagnum moss in place
D. Kill the roots

D 5. Rooting hormones are commonly used with:

A. Divisions
B. Air layering
C. Cuttings
D. Both B and C

UNIT G: HORTICULTURE

PROBLEM AREA: CARING FOR INDOOR PLANTS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade or second-year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is the winter months. The estimated time for teaching this problem area is 5 to 10 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. Adjustments to the suggested foliage plant list should be made as changes to the state contest list are made.

2. Students will have the opportunity to perform "hands-on" activities which can supplement the classroom instruction.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modifications as the teacher adapts this problem area to his/her local situation.

CREDIT SOURCES:

These materials were developed through a funding agreement, R-33-32-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed as policy or opinion of the Illinois State Board of Education or its staff.

The teacher's guide, worksheets, and test questions were developed by Ron Biondo, Department of Vocational and Technical Education, University of Illinois. The slidefilms and subject matter units were prepared by Vocational Agriculture Service, University of Illinois. The Horticulture Fact Sheets were prepared by the University of Illinois Cooperative Extension Service. The Information Sheet "Foliage Plant Care Code" was adapted from Exotic House Plants, A. B. Graf.

Suggestions and guidance in the development of these materials were provided by Paul Hemp, Department of Vocational and Technical Education, University of Illinois and the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Horticulture

II. Problem area: Caring for indoor plants

III. Objectives: At the close of this problem area students will:

1. Be able to identify 20 major house plants by common names.
2. Know how to correctly pot house plants and understand the soil requirements of selected plants.
3. Know how to adjust watering and fertilizing practices to meet the needs of different plants.
4. Be able to associate light, humidity, and temperature requirements with selected house plants.
5. Be able to identify major house plant pests and diseases.

IV. Suggested interest approaches:

1. Ask the students if they have house plants at home. If so, ask what kinds of plants they have, and what plant care practices they follow.
2. Ask the class if anyone would be interested in growing and caring for foliage plants as a career.
3. Raise the following questions:
    a. Do house plants improve the appearance of the rooms in which they are located?
    b. Do rooms with house plants feel more comfortable or warm than rooms without house plants?

V. Anticipated problems and concerns of the students:

1. Why is it important to be able to identify house plants?
2. Why do many peperomias look so different?
3. What is the difference between Philodendron and Devil's Ivy?
4. What are the advantages of clay and plastic pots?

5. How can I determine if a plant is pot bound?

6. What is meant by overpotting?

7. Are drainage holes required in pots?

8. I have a dark corner in my room. Will any plant grow in that location?

9. Can I move my plants outside in the sunshine on warm days?

10. How effective are "grow" lights?

11. Is it a good practice to water all my plants once a week?

12. What is subirrigating?

13. How can I get rid of the salt buildup on the soil and the edges of the pot?

14. There are so many fertilizers I can buy. Which is the best?

15. What are slow release fertilizers?

16. What are mealy bugs?

17. Why do the leaves of my Spider Plants become brown at the tips?

18. Why do the leaves of my Dieffenbachia have white patches and rings?

VI. Suggested learning activities and experiences:

1. Have students bring a plant to class and care for it during the year.

2. Display the house plants to be learned in the greenhouse or classroom, and provide 5-10 minutes of class time each day for the students to examine the plants.

3. Show VAS Slidefilms 610, 611, and 612 on foliage plant identification.

4. Have the students complete Student Worksheet "Plant Care", using the Information Sheet "Plant Care Code," notes and books.

5. Take a field trip to a conservatory or commercial greenhouse.

6. Discuss soil and water relationships in pots.

7. Discuss the steps used in potting foilage plants.

8. Show VAS Slidefilm 613 which illustrates correct planting techniques.

9. Have the students re-pot plants in the greenhouse or classroom.

10. Show the students examples of root-bound plants and discuss symptoms which result.

11. Demonstrate symptoms of inadequate lighting by placing one coleus in a dark area of the room and an identical plant in a sunny location. Note changes in two to three weeks.

12. Show the class how cold temperatures can stunt growth. Place a plant on a cold window sill and compare its growth to plants growing in warm conditions.

13. Discuss the symptoms of temperature extremes, light extremes, watering extremes, and fertilizing extremes.

14. Discuss the major house plant insect pests, diseases and their control.

15. Participate in the local, sectional, and state ornamental horticulture judging contests.

16. Have a local florist shop owner appear as a guest speaker.

VIII. Application procedures:

1. Skills learned in plant care can be applied in home situations.

2. Plant care skills learned in this problem area will aid students working for garden centers, plant rental companies, florists, etc.

VIII. Evaluation:

1. Administer an identification quiz before teaching cultural practices.

2. Collect and grade worksheet completed by the students.

3. Administer an objective test to the students at the close of this problem area.

IX. References:

1. University of Illinois, College of Agriculture, Vocational Agriculture Service.

    a. Slidefilms:

610	"Foliage Plant Identification Part I"	49Fr.
611	"Foliage Plant Identification Part II"	49fr.
612	"Foliage Plant Identification Part III"	55 fr.
613	"Planting and Care of Hanging Baskets"	66 fr.

b. Subject Matter Units:

5007	"Growing Plants Indoor"
5023	"Soils for Plant Growth - Amendments for Container Soils"
5024	"Soils for Plant Growth - Standardized Growing Media"

2. University of Illinois College of Agriculture, Cooperative Extension Service.

   Horticulture Fact Sheets:

FL-1-79	"Indoor Gardening"
FL-4-79	"Container Soils are Different"
FL-5-79	"Physical Properties of a Good Container Soil Amendment"

3. Exotic House Plants, A. B. Graf, Roehrs Company, East Rutherforn, NJ, 07073

4. Information Sheets included in this problem area.

   a. "Common Plant Problems"

   b. "Plant Care Code"

INFORMATION SHEET

COMMON PLANT PROBLEMS

SYMPTOM	CAUSE	CURE
Cottony white fuzz on leaves	Mealybug	Treat plant with insecticide labeled for use against mealybug.
Brown scales on stems and leaves	Scale insects	Every three to four days, rub leaves with rubbing alcohol.
Webs in the crotches of leaves and webs on the undersides of leaves	Red spider mite	Wash plant with a mild solution of dish soap and water. (Don't do this with hairy leaves). Treat with miticide registered for use against Red Spider mites.
Small whiteflies	Whitefly	Every three to four days, rub leaves with rubbing alcohol. Treat the plant with an insecticide labeled for use against whitefly.
Green growth on soil's surface	Algae and moss	Carefully remove soil on the surface and replace with new soil.
Pale new leaves that quickly turn brown.	Lack of humidity	Raise humidity in room, if possible.
Yellowing leaves (bottom ones)	Lack of nitrogen	Fertilize and water the plant regularly.
Soft stems*	Too much water or plant set too deep in soil.	Let plant dry out, then determine how much water to give it.
Dropping old, young leaves*	Old: sudden decrease in light. Young: soil too heavy.	Old: Place in sunny area. Young: Transplant with mixture of potting soil and vermiculite or peat.
Curling leaves	No drainage hole in pot: Too much water in root zone.	Transplant to pot with drainage hole. Water when necessary.

Information Sheet (con't)

SYMPTOM	CAUSE	CURE
Black, misshapen leaves	Soil too salty	Flush salts out of soil.
Small, lackluster during new growth	Underfed or pot too small	Fertilize plant on a regular basis, or transplant to a larger pot.
Brown tips on leaves	Flouride injury	Remove damaged areas; keep soil uniformly moist.
Tan spots on leaves.	Too much direct sunlight	Reduce direct sunlight.
Black spots on leaves*	Drafts	Move plant from drafts (outside doors, heating and cooling units)

*Low light levels may cause these symptoms.

INFORMATION SHEET

PLANT CARE CODE

The plant care codes used in this problem area are intended to be only a general guide. Plants can be quite flexible in their environmental demands and have shown remarkable tolerance to adverse conditions. The codes do, however, aid beginning indoor gardeners in associating special requirements various indoor plants possess.

Next to each suggested foliage plant to be learned is a set of four letters. The letters correspond to four general environmental or growing conditions, including temperature, light, soil and watering. Reference to these growing requirements can be made when learning how to care for the various plants.

ENVIRONMENT

All the foliage plants suggested can be used for home and interior decoration at they will tolerate the reduced light of a room and the artifically dry atmosphere.

TEMPERATURE

C Cool or cold: 40-45 F (5-7°C) at night, rising to about 55°F to 60°F (13°-15°C) on a sunny day, with air; 50°F (10°C) in cloudy weather.

I Intermediate, or temperate: 50-55°F (10-13°C) at night, rising to 70°F (21°C) on a sunny day, or somewhat higher, with air; 60°F (15°C) if cloudy, before opening ventilators.

S Warm, or "Stove-house": 62-65°F (16-18°C) at night; can rise to 80 or 80°F (27-30°C) in daytime before ventilators in a greenhouse must be opened. Plants that take a rest or dormancy period, should be kept a few degrees cooler during this time until active growth is to begin again.

LIGHT

B Bright light or full sun. Preference for growth: 4000-8000 foot candles for average day length. Tolerance, for maintenance: 500-2000 foot candles, based on 16 hr. illumination. Intense light is important to most blooming plants, shrubs and trees, also flowering bulbs. Many plants which require sunlight for normal growth can be kept in good condition in the home at much lower light intensity, with artificial light, when maintenance only is desired.

F Filtered or diffused sunlight. Preference: 1000-3000 foot candles for average day length. Tolerance: 100-1000 foot candles, based on 16 hr. illumination. A simple indicator of diffused sunlight is to pass your hand over your plants and barely see its shadow. A place near a clear east window during summer is best, but a southern exposure must be lightly shaded from direct sun by slatted Venetian blinds, a bamboo screen or curtain. For mere maintenance of most plants in this group in good condition in the home, light intensity may go as low as 25 foot candles, through 100 would be better.

N No (direct) sun, shady, or away from sun. Preference: 50-500 foot candles for normal day length. There are very few plants which do not want some sunlight by preference; shade lovers are limited mostly to delicate plants from the forest floor, and ferns.

Under artificial illumination, light may be as low as 10 foot candles, but the higher intensity light would be preferable to these plants provided they are shielded from the sun. High humidity is important to the well-being of plants in this group.

SOIL

L Loam, clay, or good garden soil, usually with decayed manure and up to 1/3 part peat or humus added. Where quick runoff is desirable, include coarse builders sand; in xerophytic plants like the desert type cacti, sand may be 1/3 to 1/2 of the loam mixture. Add agricultural lime to aggregate the clay particles in soil for good drainage and aeration, as well as to sweeten it. The pasteurization of potting soils is desirable to eliminate harmful bacteria, either by steaming for 1/2 hour at 180°F, or baking moist soil in an oven at 180°-250° for 3/4 to 1 hr.

H Soil rich in humus or other organic matter such as leafmold; peatmoss is excellent for the root system but needs the addition of fertilizer to become fruitful; a little rough manure should be included, and a small amount of loam for structure; broken brick or charcoal, granite chips, perlite or coarse sand will improve drainage. Recently sphagnum moss as well as shredded firbark has been used with great success on such plants as Alocasia, Anthurium, and other aroids, even Christmas cactus, but additional feeding will be necessary. A good combination also is sphagnum peat 1 part to perlite or spongerock 1 part by volume, plus added fertilizer, or by follow-up feeding with complete fertilizer formula 1-2-1. Horticulturally sterile perlite is a volcanic mineral exploded by heat into light-weight pebbles filled with air bubbles which can attract, and hold moisture uniformly, therefore furthering a healthy root system.

O Osmunda fern fiber, often with some sphagnum moss added, and lumps of charcoal and broken pots for drainage, especially in the bottom of the pots. Lately, the use of shredded firbark (Abies concolor), with about 1/3 peatmoss added, has given spectacular results; inducing prolific roots on many orchids, anthuriums, ferns, etc. However, this material is deficient in nitrogen and should have liquid fertilizer with every second or third watering, and must always be kept damp as it is difficult uniformly mosten it again if once it is allowed to dry out.

WATERING

D Drench thoroughly then allow to become moderately dry between waterings. This admits air into the soil structure which, in turn, promotes development of a healthy white root system; wiry thick roots being characteristic in this group. Watering means soaking the root-ball penetratingly, holding the pot if necessary in a bucket, sink or tub of tepid water until air bubbles cease to rise. During the cold season, with steam heat in the living room, more frequent watering every day or two is required for most plants than from spring to fall. "Feel" the soil to determine its need for water. Desert type cacti and similar succulents will stand dryness for longer periods.

M Evenly moist but not constantly wet. Plants so classified generally have delicate, hair-like, fibrous roots, subject to rot if kept too wet, and equally burning and shrivelling if too dry, especially in hot weather. Standing in a saucer, such plants may be root-ball, without letting the soil become water-soaked and "sour". During resting periods and dropping temperatures the soil ball can be kept more on the dry side.

W Thoroughly wet, or quite moist: never allow such plants to dry out. It is good practice to keep them in a saucer of gravel saturated with water, or in a jardiniere, though drainage water should be emptied every few days to keep from becoming stagnant. Such subjects may revel in moisture but resent having "wet feet", that is having their roots left standing continuously in water. Exceptions, of course, are bog plants, and aquatics when not resting.

SUGGESTED FOLIAGE PLANTS AND CARE CODES

Aglaonema modestum Chinese Evergreen	INLD
Aphelandra squarrosa Zebra Plant	SFHM
Araucaria excelsa Northfolk Island Pine	IFHM
Asparagus sprengeri Asparagus Fern	IFLD
Brassaia actinophylla Schefflera	SFLD
Chameadorea elegans Parlor Palm	SFLM
Chlorophytum comosum Spider Plant	IFLM

Cissus rhombifolia Grape Ivy	SFLM
Codiaeum variegatum pictum Croton	SBLM
Crassula argentea Jade Plant	IBID
Dieffenbachia sp. Dumbcane	SFLD
Dizygotheca elegantissima False Aralia	SFLM
Dracaena deremensis 'Warneckei' Warneckei Dracaena	SFLM
Dracaena godseffiana Spotted-leaf Dracaena	SFLM
Dracaena sanderiana Sander's Dracaena	SFLM
Fatshedera lizei Tree Ivy	IFLM
Fatsia japonica Japanese Fatsia	CFLM
Fiscus elastica Rubber Plant	SFLM
Fiscus lyrata Fiddleleaf fig	SFLD
Hedera helix English Ivy	CFLM
Helxine soleirolii Baby's Tears	IFHM
Hypoestes sanguinolenta Polka-Dot Plant	SFHM
Maranta leuconeura kerchoveana Prayer Plant	SFLM
Monstera deliciosa Swiss Cheese Plant	SFLM

Nephrolepis exaltata bostoniensis Boston Fern	SFLM
Peperomia caperata Emerald Ripple Peperomia	SFLD
Peperomia sandersii Watermelon Peperomia	SFLD
Peperomia obtusifolia Peperomia	SFLD
Philodendron oxycardium Heartleaf Philodendron	SFLM
Pilea cadierei Aluminum Plant	SFLM
Pilea involucrata Pan-American Friendship Plant	SFHM
Pilea microphylla Artillery Plant	SFLD
Plectranthus australis Swedish Ivy	SFLD
Sansevieria trifasciata Mother-in-Law Tongue	SFLD
Saxifraga sarmentosa Strawberry Begonia	IBLD
Scindapsus aureus Devil's Ivy	SFHD
Syngonium podophyllum Nephthytis	SFLM

This "Key to Care" can at best be a general guide. Surprisingly, many plants will gradually adapt themselves to varying conditions. Tropical or subtropical climate is by no means a perfect state of affairs -- there are many chilly, wet night, and dry, exhausting days. Various plant families and their different species in themselves are the products of ages of adjustment to their habitats. There is no problem for a tropical plant to grow in Santos or in Singapore, but to do so under our north-temperature indoor conditions each must pass a severe test.

*Adapted from Exotic House Plants, A. B. Graf, Roehrs Company, East Rutherford, N.J. 07073.

STUDENT WORKSHEET

PLANT CARE

Purpose: To identify and record the cultural requirements of selected house plants.

Objective: Upon completion of this exercise, students will be able to associate various cultural requirements with selected plants.

Procedure:

1. Visit a local home in which many house plants are maintained. Identify 10 plants seen growing in the home, and in the space below record the plant name and rate its health.
2. On the chart provided record the cultural requirements for the selected plants. Refer to books, notes, and the Information Sheet "Plant Care Codes."

	House Plant Name	Health Rating			
1.	____________________	Poor	Fair	Good	Excellent
2.	____________________	Poor	Fair	Good	Excellent
3.	____________________	Poor	Fair	Good	Excellent
4.	____________________	Poor	Fair	Good	Excellent
5.	____________________	Poor	Fair	Good	Excellent
6.	____________________	Poor	Fair	Good	Excellent
7.	____________________	Poor	Fair	Good	Excellent
8.	____________________	Poor	Fair	Good	Excellent
9.	____________________	Poor	Fair	Good	Excellent
10.	____________________	Poor	Fair	Good	Excellent

STUDENT WORKSHEET

PLANT CARE

PLANT NAME	LIGHT REQUIREMENT	WATERING PRACTICE	RECOMMENDED SOIL MIX	PROPAGATION	ADDITIONAL NOTES
EXAMPLE: Airplane Plant or Spider Plant	filtered light	keep soil evenly moist	all-purpose soil	root airborne offsets	runners develop under short day conditions

TEACHER'S KEY

SAMPLE TEST QUESTIONS

CARING FOR INDOOR PLANTS

Multiple Choice

__A__ 1. Which of the following prefers moist soil?

a. Norfolk Island Pine
b. Asparagus Fern
c. Peperomia
d. Jade Plant

__D__ 2. Which plants tolerate poorly lighted locations?

a. Snake Plant
b. Devil's Ivy
c. Aglaonema
d. All the above

__E__ 3. Which plants can be trees or large shrubs?

a. Norfolk Island Pine
b. Schefflera
c. Croton
d. Both a & c
e. All the above

__D__ 4. Which plants trail or tend to have a vine-like appearance?

a. English Ivy
b. Grape Ivy
c. Pan-American Friendship Plant
d. a and b

__C__ 5. A plant which has long narrow leaves.

a. Rubber Plant
b. Fiddleleaf Fig
c. Warneckei Dracaena
d. Artillery Plant

__B__ 6. A whitish to brown buildup on the edges of pots or on the top of the soil.

a. Moss
b. Soluble salt
c. Mold
d. Mealy bug

__C__ 7. An example of a slow release fertilizer.

a. Selsun Blue
b. Kelthane
c. Osmocote
d. Malathion

__D__ 8. Plants that suddenly wilt may be

a. under-watered
b. over-watered
c. over-fertilized
d. all of the above

__D__ 9. House plants moved outside during the summer usually need more ____________________ than similar plants grown indoors.

a. fertilizer
b. water
c. bright light
d. both a & b

__D__ 10. House plants grown in conditions too dark display __________.

a. lack of leaf color
b. wilting
c. pale or spindly growth
d. both a & c

True (+) - False (0)

1. __+__ Plants can be planted in too large of a pot.

2. __0__ Most tropical plants thrive in clay soil.

3. __0__ Peperomias are easy to identify because they all look alike.

4. __+__ Watering practices depend on the light, temperature and humidity a plant receives.

5. __0__ Tropical plants should be fertilized bi-weekly to induce lush growth.

6. __0__ Mealybugs look like dark bumps on leaves or stems.

7. __+__ Many tropical plants can be propagated asexually.

8. __0__ Foliage plants should never be grown outside in the summer.

9. __+__ Most foliage plants require temperatures above 55 degrees.

10. __+__ Tall pots tend to have better drainage than short, shallow pots.

UNIT H: Agricultural Mechanics

PROBLEM AREAS:

1. Developing arc welding skills
2. Developing acetylene welding skills
3. Surveying in agriculture
4. Developing basic shop skills

UNIT H: AGRICULTURAL MECHANICS

PROBLEM AREA: DEVELOPING ARC WELDING SKILLS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth grade students enrolled in an agriculture occupations program. This problem area could be taught anytime, but it is recommended that it be taught in the early winter. This facilitates use of the shop during inclement weather and the heat produced from welding operations is more tolerable during the winter months. The estimated teaching time for this problem area is 3 to 4 weeks depending on how much time the teacher wishes to spend on discussion and actual laboratory exercises.

The materials in this problem area were selected and written with the following assumptions:

1. Arc welding is a major component of a sound agricultural mechanics program.
2. All students should gain basic arc welding skills.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts these materials to his/her local situation.

CREDIT SOURCES:

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The teacher's guide, worksheets, job sheets, information sheets, and sample test questions were prepared by Jerry Pepple, Department of Vocational and Technical Education, University of Illinois with the assistance from Dave Trent, Agricultural Occupations Instructor, Reddick High School, Reddick Illinois. The transparency masters and transparency discussion guides were developed by Vocational Agriculture Service, University of Illinois.

Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Agricultural mechanics

II. Problem area: Developing arc welding skills

III. Objectives: At the close of the problem area students will be able to:

1. Use arc welders safely.
2. Select electrodes properly.
3. Understand principles of arc welding.
4. Strike an arc and run a bead.
5. Make a groove, lap, fillet, and corner weld in the downhand position.
6. Make a groove weld in the vertical up position.
7. Make a groove weld in the vertical down position.
8. Make a groove weld in the horizontal position.

IV. Suggested interest approaches:

1. Ask students how many have welders at home and if they have welded.
2. Lead into a discussion of methods of fastening steel together.
3. Lead students into a discussion of economics of welding: such as availability of local repair shops and cost of hiring repair work done.
4. Have students examine welds made by instructor or previous students.
5. Have students take turns breaking sample groove welds.
6. Have students examine arc welders and welding equipment.
7. Ask students to list various pieces of equipment that their parents own that are welded or have been constructed at home.

V. Anticipated problems and concerns:

1. How can I keep from getting shocked?
2. How do I make a strong weld?
3. Which electrode should I use?

4. How do I change the amperage on a welder?

5. How does a welder work?

6. When can we start to weld?

7. How much does it cost to weld?

8. Why do we have to wear all those heavy clothes?

VI. Suggested learning activities and experiences:

1. Discuss problems and concerns identified by class or teacher.

2. Distribute VAS Unit 3022 as a reference and have students complete Worksheet #1.

3. Distribute VAS Unit 3004a, and conduct a demonstration on welding.

4. Have students read sections 1 and 2 of VAS Unit 3004a and complete Worksheet #2.

5. Have students read section 3 of VAS Unit 3004a and show VAS Slide film 450-64. Discuss major points of emphasis.

6. Have students complete Worksheet #3.

7. Perform some of the safety demonstrations on the safety demonstration sheet.

8. Discuss Information Sheet on "Understanding Electrodes", and have students complete Worksheet #4.

9. Have students finish reading VAS Unit 3004a and lead a discussion on the important concepts.

10. Show and discuss VAS Slidefilms 451-64 and 452-64.

11. Show transparencies, when needed, to help students visualize suggested techniques.

12. Distribute helmets and equipment to students.

13. Demonstrate striking an arc, running a bead, etc. Then, have students practice selected skills.

14. Distribute and discuss Student Check Sheets and Job Sheet Evaluation Scoresheets.

15. Have students complete Job Sheets in sequence.

VII. Evaluation:

1. Prepare and administer a pencil and paper test covering safety, equipment, principles of welding, and operation of welders.
2. Grade worksheets.
3. Record daily shop safety grades for students.

VIII. References and aids:

1. VAS Unit 3022, Safety in the Agricultural Mechanics Shop.
2. VAS Unit 3004a, Shielded Metal-Arc Welding.
3. VAS Slidefilm 450-64, Arc Welding-Process, Equipment and Safety.
4. VAS Slidefilm 451-64, Arc Welding-Flat Position Welding.
5. VAS Slidefilm 452-64, Arc Welding-Vertical, Horizontal and Overhead Welding.
6. Shielded Metal-Arc Welding Transparencies, Vocational Agriculture Service, University of Illinois.
7. Worksheets 1,2,3, and 4.
8. Information Sheets 1 and 2.
9. Safety Demonstrations.
10. Student Check Sheet.
11. Student and Instructor Job Sheet Evaluation Scoresheet.
12. Job Sheets, 1,2,3,4,5,6,7,8, and 9.

INFORMATION SHEET

SUGGESTED SAFETY DEMONSTRATIONS FOR ARC WELDING*

1. Demonstrate proper use of a fire blanket.
2. Demonstrate methods of making clothing and blankets fire resistant by soaking in lukewarm solution of one pound of borax and 13 ounces of boric acid in 2 gallons of water. Mention that this is not permanent and needs to be repeated after laundering.
3. Refer to Job Sheet 1 on page 1-H-3-15 in Core I on fire extinguishers and repeat for Core II welding students.
4. Show the difference in flammability on frayed clothing compared to unfrayed clothing by igniting both with matches and comparing ignition time. Use steel pans for the fire and use extreme caution.
5. Compare burning characteristics of greasy or oily clothing compared to clean, fire-treated clothing by burning in a metal pan in a safe location.
6. Demonstrate the correct method of chipping a weld. Chip gently from the side, directing the slag away from the person chipping.
7. Demonstrate safe methods for breaking welds, as explained in procedure 7 on Job Sheet 3.
8. Stress the importance of not carrying butane lighters. Under the proper conditions, butane lighters will explode with the force equal to 1 stick of dynamite. DO NOT DEMONSTRATE THIS!

*These suggested demonstrations should be used by the teacher only after he/she is satisfied that they can be safely conducted.

INFORMATION SHEET

UNDERSTANDING ELECTRODES

The 4 digit numbering system will be discussed. The type of chemical in the flux coating will not be discussed. If interested, refer to page 14, table 4 in VAS Unit 3004. Also the spot system will not be discussed. If interested, refer to table 3 on page 11 of VAS Unit 3004.

The 4 digit numbering system is an attempt to insure uniformity of electrode selection and usage between companies producing electrodes.

Example E 6011

E- stands for electrode and signifies that the electrode is for arc welding.

1st 2 digits "60" refer to the tensile strength of the steel in the electrode in thousands of pounds per square inch.

3rd digit refers to the position that the electrode is suitable for.

1-suitable for all welding positions
2-suitable for downhand and hortizontal welding only
3-suitable for downward only
(Note, a 2 or 3 in the 3rd digit usually means the puddle is larger and has a tendancy to run or sag in out of position welds)

4th digit refers to type of flux coating and determines characteristics of electrodes.

O-DC only

1-AC or DC, deep penetration, flat weld, thin slag, excessive splatter.

2-AC or DCSP, medium penetration, quiet arc, fast flow (used for poor fit up).

3-AC or DC, mild penetration, quiet arc, easy to chip, good, appearance (for sheet metal)

4-AC or DC, iron powder, good appearance, easy to chip, mild penetration, supplies additional filler metal, requires excessive heat, used in high speed production where appearance is desirable and penetration is not important.

5-DCRP, high strength, high carbon steels, prevents underbead cracking, mild to medium penetration, easy to chip.

6-AC or DCRP, low hydrogen, used for high carbon, high sulfur or cold rolled steel, prevents cracks and porosity.

7-AC or DCSP, mild penetration and heavy slag, iron powder and mineral coating (used for tanks, heavy pipe, and construction or railroad equipment).

8-AC or DCRP, iron powder and low hydrogen. Same application as 6 but better weld appearance (used in high carbon or cold rolled steel that is hard to weld.)

INFORMATION SHEET

EXPLANATION OF JOB SHEETS

1. On Job Sheets 1,2,3,4,5,6, it is recommended that a 1/8" E6013 electrode be used. Granted the penetration is poor, but the E6013 is an electrode that will produce a good looking bead with minimum splatter and is easy to chip. This is especially important if excessive chipping noise is objectionable.

2. On Job Sheets 7,8,9, it is recommended that an E6011 1/8" electrode be used. Although there is more splatter and it is more difficult to chip, the puddle tends to sag less, due in part to increased penetration.

3. On all Job Sheets except #8, it is recommended that 1/4" mild steel be used. This will allow students to complete the weld with only one pass. Thicker steel may be used if multiple passes are desired.

4. On Job Sheet #8, 3/16: mild steel is recommended. Penetration is a problem with steel thicker than 3/16" in a vertical down position.

5. Instructors might choose to have students complete vertical up, vertical down, and horizontal beads instead of groove welds or these beads might be done in addition to groove welds. The format would be the same as on the job sheets, only one piece of steel would be required and no breaking of welds would be required.

6. If time allows, students might be allowed to go back to other job sheets after completing Job Sheet #9 in order to improve their grades.

7. It is recommended that daily safety grades be given on such things as safe procedures, correct use of protective clothing, correct use of head shield and safety glasses, and correct chipping and breaking procedures.

8. If welding jigs are not available, lean work against pipe bolted to the table or devise other methods of supporting the work for out-of-position welds.

INFORMATION SHEET

STUDENT CHECK SHEET

Place an X in the box in front of each exercise after it has been completed and is graded by the instructor. Place the score received in the box to the right of each exercise.

		Score Received
☐	STRIKE AN ARC 10 CONSECUTIVE TIMES	
☐	RUN A DOWNHAND BEAD	
☐	RUN A DOWNHAND GROOVE WELD	
☐	RUN A DOWNHAND LAP WELD	
☐	RUN A DOWNHAND FILLET WELD	
☐	RUN A DOWNHAND CORNER WELD	
☐	RUN A VERTICAL DOWN GROOVE WELD	
☐	RUN A VERTICAL UP GROOVE WELD	
☐	RUN A HORIZONTAL GROOVE WELD	

INFORMATION SHEET

STUDENT AND INSTRUCTOR JOB SHEET EVALUATION SCORE SHEET

STUDENT NAME____

NAME OF EXERCISE____________________________________

Inspection. Check welds for the following:

1. width and buildup (uniformity)
2. appearance - smooth with uniform ripple
3. face of bead, slightly convex, free from voids and high spots
4. edge of bead, good fusion, no overlap, no undercut
5. beginnings and endings - full sized craters filled
6. penetration and fusion - (if applicable) no sags but fairly complete through plate surface
7. surrounding plate surface - free from excessive splatter
8. slag formation - easy removal and full coverage

Possible points	My Score	Instructor's Score
1. 15		
2. 15		
3. 15		
4. 15		
5. 5		
6. 15		
7. 10		
8. 10		
total 100		

STUDENT WORKSHEET 1

ARC WELDING SAFETY

(Refer to VAS Unit 3022, section 16)

1. List 4 things that can be done to avoid burning yourself or others.

   A.

   B.

   C.

   D.

2. List 4 things that can be done to avoid injuring your eyes or the eyes of other students.

   A.

   B.

   C.

   D.

3. List 4 things that can be done to avoid shock.

   A.

   B.

   C.

   D.

4. List 2 things that can be done to prevent fires.

   A.

   B.

STUDENT WORKSHEET 2

ARC WELDING EQUIPMENT

(R[redacted]'AS Unit 3004 section ! and 2)

1. Other than shielded metal-arc welding, list 3 other types of electric welding.

   A.

   B.

   C.

2. What historical arc welding events happened on the following dates?

   1801-

   1881-

   1887-

   1910-

   World War I

   World War II

3. What is meant by the term "Duty Cycle"?

4. What are 6 advantages of an AC transformer welder over a DC welder?

   A.

   B.

   C.

   D.

   E.

   F.

5. List 10 accessories that are available for arc welders.

   A. ____________

   B. ____________

   C. ____________

   D. ____________

   E. ____________

   F. ____________

   G. ____________

   H. ____________

   I. ____________

   J. ____________

STUDENT WORKSHEET 3

ARC WELDING SAFETY

(Refer to VAS Unit 3004, section 3 and VAS Slidefilm 450-64)

1. What does NEMA approved mean?

2. List at least 5 methods of preventing electrical shock.

   A.

   B.

   C.

   D.

   E.

3. List 3 methods of preventing eye injury.

   A.

   B.

   C.

4. What is the recommended procedure for treating eye injuries? (list 4)

   A.

   B.

   C.

   D.

5. How should you dress to prevent burns? (list at least 6)

   A.

   B.

   C.

   D.

   E.

   F.

6. What should you do to prevent fires? (list 4)

   A.

   B.

   C.

   D.

7. If you or another student is on fire, what should you do? (list 5)

   A.

   B.

   C.

   D.

   E.

8. Which fire extinguishers should be used for the following?

   A. Wood, cloth, or paper fire ____________________

   B. Flammable liquid fire ____________________

   C. Electrical fire ____________________

STUDENT WORKSHEET 4

ELECTRODE SELECTION

(Refer to Information Sheet #1)

1. What are 4 purposes of an electrode?

   A.

   B.

   C.

   D.

2. In the 4 digit numbering system for electrodes, what does the E stand for?

3. In the 4 digit numbering system for electrodes, what do the Ist 2 digits mean?

4. In the 4 digit numbering system for electrodes, what does the 3rd digit refer to?

5. In the 4 digit numbering system for electrodes, what does the 4th digit refer to?

6. Given the following 3rd digits, tell what position the electrode is intended for.

   A. 1 ____________________

   B. 2 ____________________

   C. 3. ____________________

7. Given the following 4th digits, tell something about each electrode.

   A. 0
   B. 1
   C. 2
   D. 3
   E. 4
   F. 5
   G. 6
   H. 7
   I. 8

JOB SHEET #1

PREPARING TO WELD AND STRIKING AN ARC

OBJECTIVES:

1. To become proficient in preparing to weld.
2. To become proficient in striking an arc.
3. To be able to weld in a safe manner.

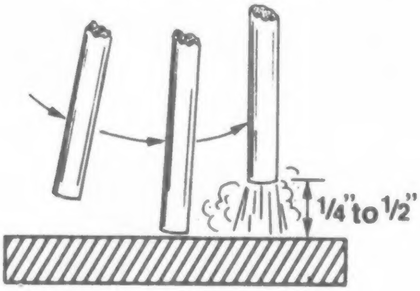
MATERIALS:

1. Arc welding station and required tools.
2. Protective clothing and equipment.
3. E 6013 1/8" electrodes.
4. Mild steel plate 1/4" to 3/8" thick.

PROCEDURE:

1. Prepare work area so that everything is convenient.
2. Remove all combustibles from welding area.
3. Check cables for loose connections and breaks in insulation.
4. Put on protective equipment.
5. Attach ground clamp to table or to metal, removing paint or rust as necessary to get a good contact.
6. Plug welder in.
7. Select proper amperage. (Use 100-120 amps as trial setting)
8. Place bare end of electrode in electrode holder at 90 degree angle.
9. Turn welder on.
10. Position electrode over work-support right hand with left hand and place left elbow on table for support. (If left handed, reverse)
11. Lower headshield.
12. Strike arc by using a scratching motion and raising electrode tip approximately 1/4" to 1/2" above work.
13. If electrode sticks, use a jerking motion to free it.
14. Extinguish arc by raising electrode tip.
15. Continue practicing striking arc.
16. Have instructor grade procedure and ability to strike 10 consecutive arcs.
17. After being graded, move on to Job Sheet #2.

STRIKING AN ARC



JOB SHEET #2

RUNNING A DOWNHAND BEAD

Objectives:

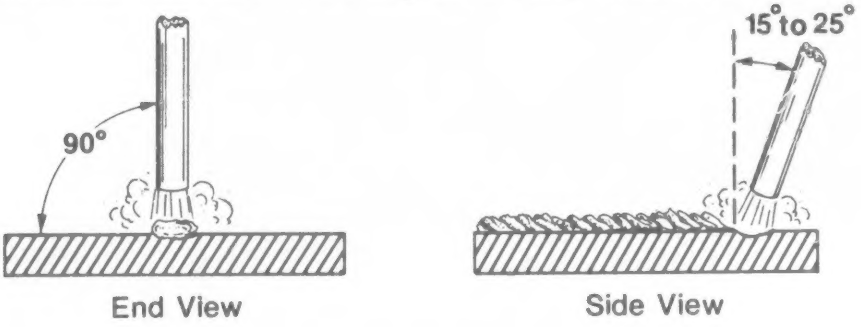
1. To run a bead in a safe manner.
2. To be able to control amperage, arc length, travel speed, and electrode angle to obtain a satisfactory bead.

MATERIAL:

1. Arc welding station and required tools.
2. Protective clothing and equipment.
3. E 6013 1/8" electrode.
4. 1/4" thick mild steel approximately 4"×6".
5. Soapstone.

PROCEDURE:

1. Mark a straight line on the mild steel with a soapstone and straight edge.
2. Follow procedures 1-12 on Job Sheet #1.
3. Run a bead from the left side of the metal to the right side if right handed.
4. Maintain correct amperage, arc length, travel speed, and electrode angle. (Refer to Slidefilm 451-64)
    a. Use 100-120 as trial amperage setting.
    b. Maintain 1/8" arc length., (Listen for frying sound)
    c. Move from left to right if right handed., (Reverse if left handed)
    d. Travel at a uniform speed to produce a bead 3/16" wide.
    e. Lean the electrode 15-25 degrees in the direction of travel.



5. Fill crater when stopping arc by shortening arc, hesitating, move backward slightly, and lift electrode quickly.
6. Chip slag down bead while wearing safety glasses or goggles.
7. Inspect bead. (Use Slidefilm 451-64 for examples)
8. Continue to practice until you are ready to be graded.
9. Evaluate your bead and have instructor grade using Job Sheet Score Sheet.
10. Proceed to Job Sheet #3

JOB SHEET #3

RUNNING A DOWNHAND GROOVE WELD

OBJECTIVES:

1. To be able to make a downhand groove weld.
2. To be able to weld in a safe manner.
3. To be able to evaluate the weld using the scoresheet.

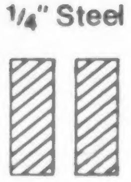
MATERIAL:

1. Arc welding station and required tools.
2. Protective clothing and equipment.
3. E 6013 1/8" electrode.
4. 2 pieces 1/4" mild steel 4x6".
5. Bench grinder if necessary.
6. Well supported and secured vise.
7. 40 oz. machinist hammer.

PROCEDURE:

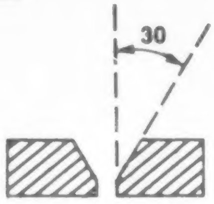
1. Follow procedures 1-12 on Job Sheet #1.
2. Tack mild steel for welding. (Tack both ends)
    a. If less than 1/4" thick separate steel 1/8" (½ thickness of steel).
    b. If steel is 1/4" to 1/2 in. thick, grind a 30 degree level on the edge of the steel to form a single V when the two are tacked together.
    c. If the steel is more than 1/2" thick, grind a 30 degree level on each side to form a double V. (Use safety glasses when grinding)

A.



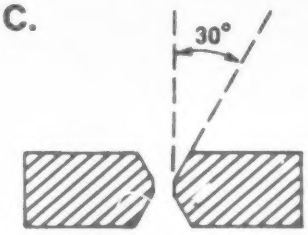
1/8" Gap

B.



Single V

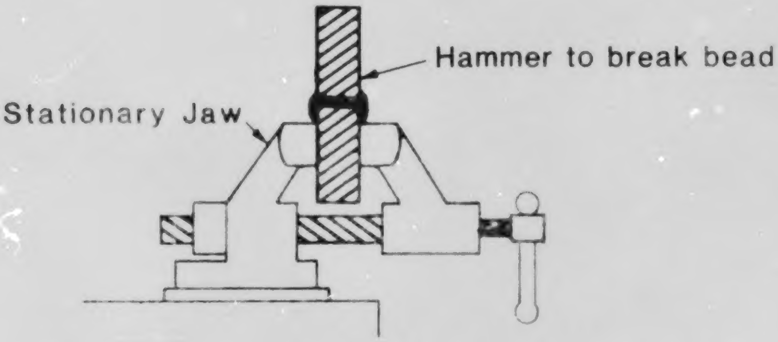
C.



Double V

3. Support both pieces so the gap is not resting on the welding table.
4. Run a bead following the groove made by the 2 pieces being joined.
5. Chip the weld in a safe manner and allow to air cool. (Weld may be cooled in water after 5 minutes)

6. Make additional passes if necessary to completely fill the groove.
7. Observe the groove weld and then break it to check strength.
    a. Place weld in stationary vise with the weld facing the stationary jaw.
    b. Use a 40 oz. machinist hammer, hammering towards the stationary jaw.
    c. Use safety glasses.



8. Continue practicing until ready for grading. (Don't break the groove weld that is to be graded)
9. Evaluate the weld using Job Sheet Score Sheet.
10. Proceed to Job Sheet #4.

JOB SHEET #4

RUNNING A DOWNHAND LAP WELD

OBJECTIVES:

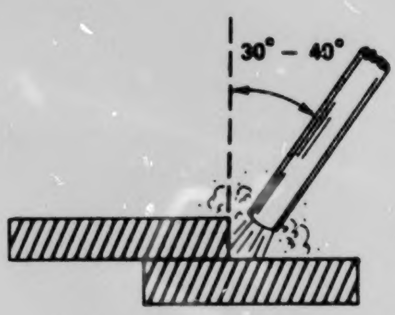
1. To be able to make a strong and neat downhand lap weld.
2. To be able to weld in a safe manner.

MATERIALS:

1. Arc welding station and required tools.
2. Protective clothing and equipment.
3. E 6013 1/8" electrode.
4. 2 pieces of 1/4" mild steel 4x6".
5. Well supported and secured vise.
6. 40 oz. machinist hammer.

PROCEDURE:

1. Follow procedures 1-12 on Job Sheet #1.
2. Tack mild steel for welding.
3. Run a single pass weld while controlling the following:
    a. arc length
    b. travel speed
    c. amperage setting
    d. electrode angles

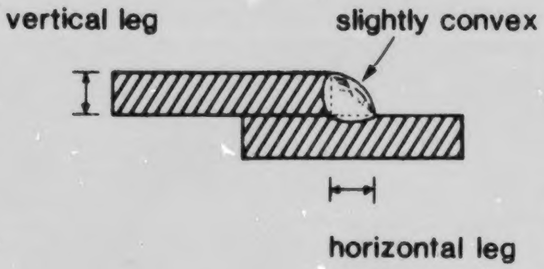


End View

Continue 15 degree lean in direction of travel. Electrode angle should be 30-40 degrees when viewed from the end. Electrode should point slightly more towards the top plate than the bottom plate due to the differences in heat dissipation.

4. Remove slag and allow to air cool.

5. Examine weld.


vertical leg
slightly convex
horizontal leg

Width of deposit on lower plate should be equal to the thickness of top plate.

6. Break the weld following procedure 7 on Job Sheet #3.
7. Continue practicing until ready for grading. Do not break the weld to be graded.
8. Evaluate the weld using the Job Sheet Score Sheet.
9. Proceed to Job Sheet #5.

JOB SHEET #5

RUNNING A DOWNHAND FILLET WELD

OBJECTIVES:

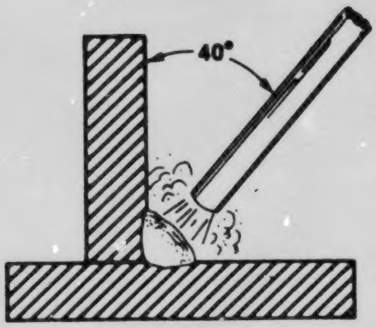
1. To become proficient in running a downhand fillet weld.
2. To be able to produce a strong, attractive fillet weld.
3. To be able to weld in a safe manner.

MATERIAL:

1. Arc welding station and required tools.
2. Protective clothing and equipment.
3. E 6013 1/8" electrode.
4. 2 pieces 1/4" mild steel 4x6".
5. Well supported and secured vise.
6. 40 oz. machinist hammer.

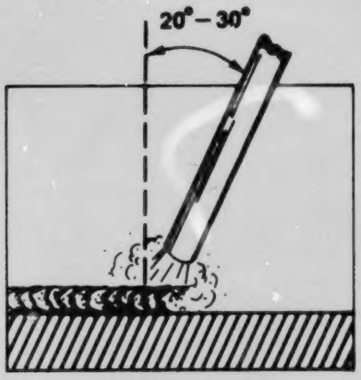
PROCEDURE:

1. Follow procedures 1-12 on Job Sheet #1.
2. Tack mild steel for welding.
3. Run a single pass fillet while controlling:
    a. amperage setting (if necessary)
    b. arc length
    c. travel speed
    d. electrode angle



End View

20° to 30° lead angle
Lean in direction of travel

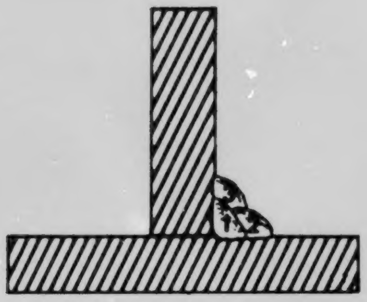


Side View

Use less than a 45 degree angle as vertical piece will heat faster than horizontal piece. (Direct electrode slightly more to horizontal piece)

4. Remove slag and air cool.

5. Observe weld. Make additional passes if necessary so that leg length equals thickness of bottom plate.



6. Break weld using procedure 7 on Job Sheet #3.
7. Examine broken weld. (Weld should break in middle)
8. Continue practicing until ready for grading. Don't break weld to be graded.
9. Evaluate the weld using Job Sheet Score Sheet.
10. Proceed to Job Sheet #6.

JOB SHEET #6

RUNNING A DOWNHAND CORNER WELD

OBJECTIVES:

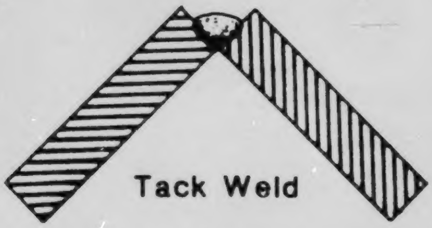
1. To produce a strong and attractive downhand corner weld.
2. To evaluate the weld using the Job Sheet Score Sheet
3. To be able to produce a corner weld in a safe manner.

MATERIALS:

1. Arc welding station and required tools.
2. Protective clothing and equipment.
3. E 6013 1/8" electrode.
4. 2 pieces 1/4" mild steel 4x6".
5. Well supported and secured vise.

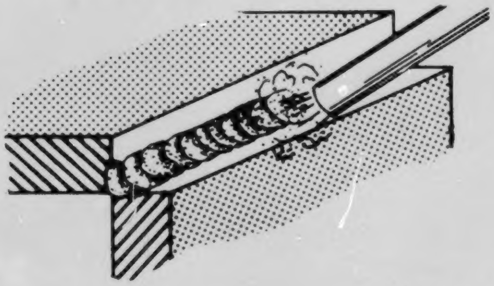
PROCEDURES:

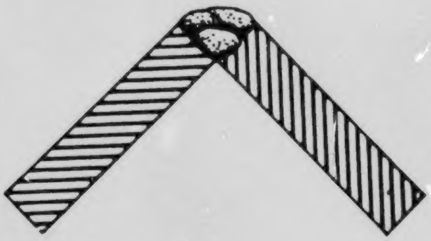
1. Follow the procedures 1-12 on Job Sheet #1.
2. Tack mild steel together to make a full open joint.



3. Run a single pass corner weld while maintaining:
    a. proper amperage
    b. proper arc length
    c. proper travel speed (travel slowly enough to maintain keyhole)
    d. proper electrode angle (use same angles as bead)

5. Remove slag and air cool.
6. Make additional passes if necessary. (Resultant weld should be rounded on the top)





7. Break by squeezing in the vise.
8. Examine broken weld.
9. Continue practicing until ready to grade.
10. Evaluate using job sheet score sheet. Don't break the weld the instructor is to grade.
11. Proceed to Job Sheet #7.

JOB SHEET #7

RUNNING A GROOVE WELD IN THE VERTICAL UP POSITION

OBJECTIVES:

1. To become proficient in making vertical up welds.
2. To be able to weld in a safe manner.

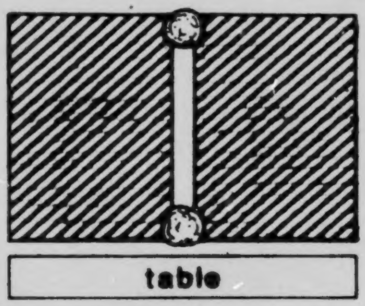
MATERIALS:

1. Welding station and required tools.
2. Protective clothing and equipment.
3. E 6011 1/8" electrode.
4. 2 pieces 1/4" mild steel 4x6".
5. Welding jig similar to the one in frame 21 of VAS Slidefilm 452-64.
6. Well supported and secured vise.
7. 40 oz. machinist hammer.

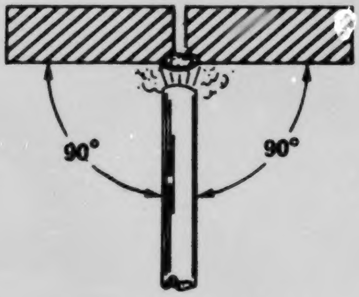
PROCEDURES:

1. Follow procedures 1-12 on Job Sheet #1. (Insert electrode into electrode holder at a 45 degree angle instead of 90 degrees.)
2. Prepare steel for welding as in procedure 2 on Job Sheet #3.
3. Stand the steel up or place in welding jig so that the groove is in a position at a right angle to the table.

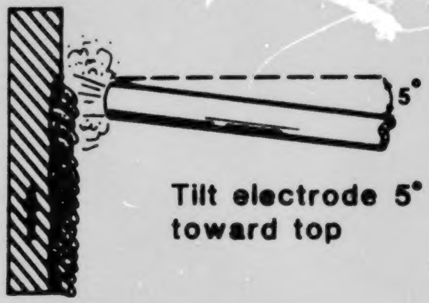
Front View



4. Run a vertical up groove starting at the bottom of the steel and working towards the top.
5. Maintain correct arc length, electrode angle, travel speed, and U-shaped weave to prevent the puddle from dripping and sagging.



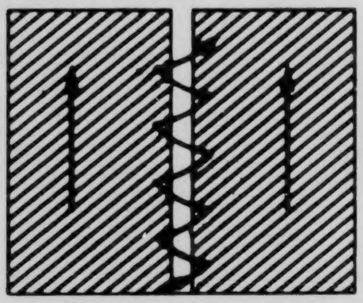
View from above



Tilt electrode 5° toward top

Side View

6. Use a U-shaped motion to control the puddle. On the outside edges hold a long arc and in the center of the puddle hold a short arc. Hesitate on the outer edges in order to help the center puddle solidify. The weld should be approximately 1/2 inch wide. (If puddle starts to sag, hesitate more on the outer edges.)



Front View

7. Remove slag and air cool.
8. Break weld after observing it. Use the procedure 7 on Job Sheet #3 to break.
9. Continue practicing until ready for grading. Don't break the weld to be graded.
10. Evaluate the weld using the Job Sheet Score Sheet.
11. Proceed to Job Sheet #8.

JOB SHEET #8

RUNNING A GROOVE WELD IN THE VERTICAL DOWN POSITION.

OBJECTIVES:

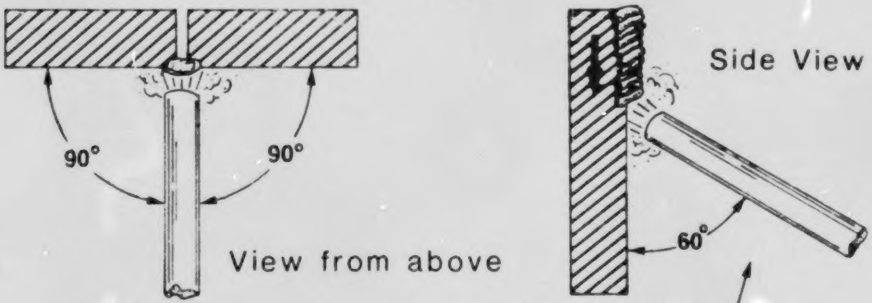
1. To become proficient in making vertical down welds.
2. To be able to make vertical down welds in a safe manner.
3. To produce an attractive, strong vertical down weld.

MATERIALS:

1. Arc welding station and required tools.
2. Protective clothing and equipment.
3. E 6011 1/8" electrode.
4. 2 pieces of 3/16" mild steel 4x6". (Vertical down welds are usually unsatisfactory for steel thicker than 3/16".)
5. Welding jig.
6. Well supported and secured vise.
7. 40 oz. machinist hammer.

PROCEDURES:

1. Follow procedures 1-3 on Job Sheet #7.
2. Run a vertical down groove weld starting at the top of the steel and working towards the bottom.
3. Maintain uniform arc length, uniform travel speed, and correct electrode angle. Travel speed should be as slow as possible but fast enough to keep the molten metal from running ahead of the crater. A slight weaving motion might be used to control the puddle and obtain a heavier bead.



Point the electrode up at an angle of 60 degrees

4. Remove slag and air cool.
5. Break the weld using procedure 7 on Job Sheet #3.
6. Continue practicing until ready for grading. Don't break the weld you are going to have graded.
7. Evaluate the vertical down weld using the Job Sheet Score Sheet.
8. Proceed to Job Sheet #9.

JOB SHEET #9

RUNNING A GROOVE WELD IN THE HORIZONTAL POSITION

OBJECTIVES:

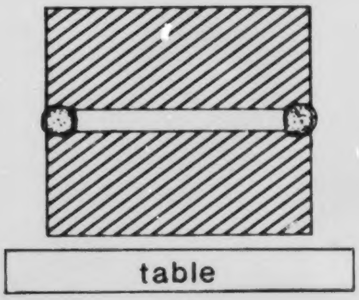
1. To become proficient in making horizontal groove welds.
2. To make horizontal welds in a safe manner.
3. To provide strong, attractive horizontal groove welds.

MATERIALS:

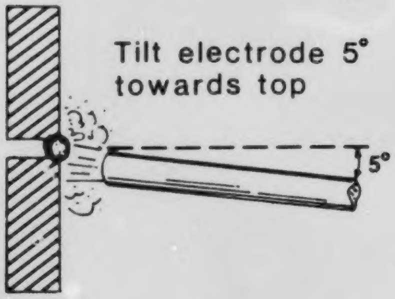
1. Welding station and required tools.
2. Protective clothing and equipment.
3. E 6011 1/8" electrodes.
4. 2 pieces 1/4" mild steel 4x6".
5. Welding jig.
6. Well supported and secured vise.
7. 40 oz. machinist hammer.

PROCEDURES:

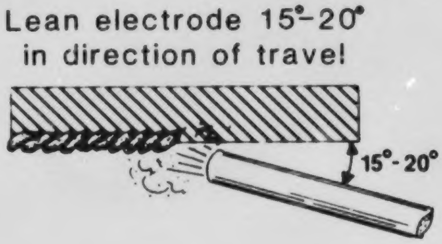
1. Follow procedures 1 and 2 on Job Sheet #7.
2. Stand the steel up or place in a welding jig so that the groove is in a position parallel to the table.



3. Run a horizontal groove weld from the left side to the right side if right handed.
4. Maintain correct arc length, travel speed, and electrode angle.

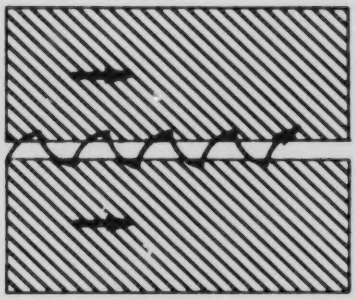

Tilt electrode 5° towards top
5°

Side View

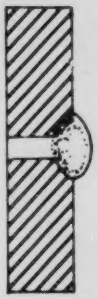

Lean electrode 15°-20° in direction of travel
15°-20°

Top View

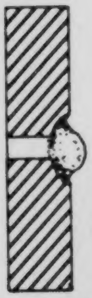
5. Use a weaving motion when welding in the horizontal position.



6. Remove slag and allow to air cool.
7. Examine weld.



Normal Bead



Undercut Bead

8. Break weld as in procedure 7 on Job Sheet #3.
9. Continue practicing until ready for grading but don't break the weld you are going to have graded.
10. Evaluate the horizontal groove weld using the job sheet score sheet.
11. If time permits, go over all job sheets to improve welds.

TEACHER'S KEY

STUDENT WORKSHEET 1

ARC WELDING SAFETY

(Refer to VAS Unit 3022, section 16)

1. List 4 things that can be done to avoid burning yourself or others.
   - A. Wear high top shoes.
   - B. Avoid clothing with turned up cuffs.
   - C. Keep collars and pockets buttoned.
   - D. Do not leave hot metals where others might pick them up.
2. List 4 things that can be done to avoid injuring your eyes or the eyes of other students.
   - A. Wear helmet.
   - B. Wear goggles.
   - C. Don't strike an arc before covering your face with shield.
   - D. Warn persons near by when beginning to weld.
3. List 4 things that can be done to avoid shock.
   - A. Wear gloves.
   - B. Disconnect welder when working on it.
   - C. Guard against saturation of clothing by moisture or perspiration.
   - D. Inspect welding cables for breaks in insulation.
4. List 2 things that can be done to prevent fires.
   - A. Clear all combustibles out of welding area.
   - B. Do not weld barrels or other containers that contained combustible material.

TEACHER'S KEY

STUDENT WORKSHEET 2

ARC WELDING EQUIPMENT

(Refer to VAS Unit 3004 section 1 and 2)

1. Other than shielded metal-arc welding, list 3 other types of electric welding.

   A. Spot

   B. TIG

   C. MIG

2. What historical arc welding events happened on the following dates or periods?

   1801- First electric arc

   1881- Lead plates welded together with arc

   1887- First bare electrode

   1910- First flux coated electrode

   World War I - Quick repairs

   World War II - Welding used for fabrication

3. What is meant by the term "Duty Cycle" - % of a 10 minute period that a welder can operate at a given amperage setting?

4. What are 6 advantages of an AC transformer welder over a DC welder?

   A. low initial cost

   B. low operating cost

   C. few moving parts

   D. high electrical efficiency

   E. smaller and lighter than other kinds

   F. low noise level

   G. arc blow is non-existant

5. List 10 accessories that are available for arc welders.

A. cables

B. headshield

C. electrode holder

D. welding table

E. ground clamp

F. safety goggles

G. chipping hammer

H. wire brush

I. mild steel electrodes

J. carbon arc torch

TEACHER'S KEY

STUDENT WORKSHEET 3

ARC WELDING SAFETY

(May be used in conjunction with or instead of Worksheet 1)

1. What does NEMA approved mean? Equipment has met certain standards for safety set up by National Electrical Manufacturers Association.

2. List at least 5 methods of preventing electrical shock.

   A. Use equipment of safe design.

   B. Use proper electrical service.

   C. Inspect cables regularly for breaks and loose connections.

   D. Weld only in a dry area.

   E. Don't touch both ends of an open electrical circuit.

   F. Don't use welder case as a step or as a support for heavy objects.

   G. Wear leather gloves.

   H. Keep your body well insulated.

3. List 3 methods of preventing eye injury.

   A. Warn bystanders to look away when you strike an arc.

   B. Use a helmet or hand shield with approved shade.

   C. Wear goggles when chipping, breaking, or grinding.

4. What is the recommended procedure for treating eye injuries? (list 4)

   A. Apply cold compress or ice pack.

   B. Flush eyes with tepid water or saline solution.

   C. Cover the eye with sterile cloth.

   D. Get prompt medical attention.

5. How should you dress to prevent burns? (list at least 6)

   A. Wear clothing that is free from oil or grease.

B. Don't wear frayed clothing.

C. Wear long sleeve shirts and keep collars, pockets and sleeves buttoned.

D. Avoid cuffs in pants.

E. Wear high top shoes.

F. Keep matches, paper, and butane lighters out of pockets.

G. Wear gauntlet type leather gloves.

6. What should you do to prevent fires? (list 4)

   A. Keep area free of combustibles.

   B. Wear approved clothing.

   C. Don't weld on containers that held combustible material.

   D. Follow proper precautions when welding on machinery.

7. If you or another student is on fire, what should you do? (list 5)

   A. Strip off article on fire.

   B. Wrap in a fire blanket.

   C. Fold arms across face to avoid inhaling fire.

   D. Roll on floor slowly if no fire blanket is available.

   E. Do not run.

8. Which fire extinguishers should be used if necessary?

   A. Wood, cloth, or paper fire. Use foam, water, soda acid, dry powder, or CO2

   B. Flammable liquid fire. Dry powder or CO2

   C. Electrical fire. Dry powder or CO2

TEACHER'S KEY

STUDENT WORKSHEET 4

ELECTRODE SELECTION

(Refer to Information Sheet #1)

1. What are 4 purposes of an electrode?

   A. Provides filler metal.
   B. Flux coating creates ionized gas to conduct electricity.
   C. Burning flux removes impurities.
   D. Burning flux shields the weld from the air to allow it to cool slower.

2. In the 4 digit numbering system for electrodes, what does the E stand for? ELECTRODE

3. In the 4 digit numbering system for electrodes, what do the lst 2 digits mean?
   The tensile strength of the steel in the electrode in thousands of PSI.

4. In the 4 digit numbering system for electrodes, what does the 3rd digit refer to?
   The position that the electrode can be used in.

5. In the 4 digit numbering system for electrodes, what does the 4th digit refer to?
   Type of flux coating.

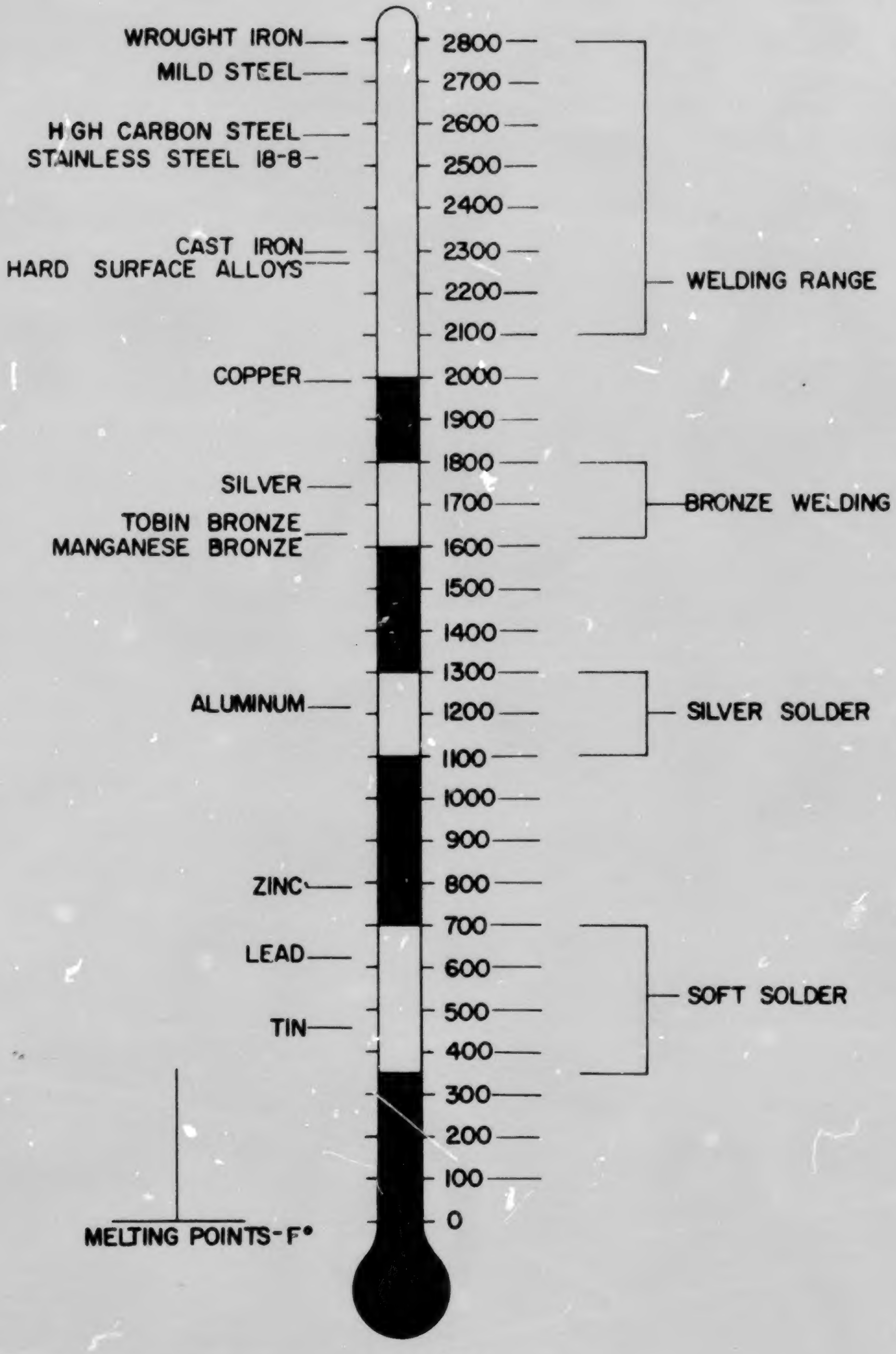
6. Given the following 3rd digits, tell what position the electrode is intended for.

   A. 1 All position.
   B. 2 Downhand and horizontal.
   C. 3. Downhand only.

7. Given the following 4th digits, tell something about each electrode.

   A. 0 DC only.
   B. 1 Deep penetration.
   C. 2 Poor fit up, fast flow. shallow penetration.
   D. 3 Mild penetration, good appearance, sheet metal, chips easily.
   E. 4 Iron powder, mild penetration, good appearance.
   F. 5 High carbon steel.
   G. 6 Low hydrogen, used for high carbon steel, high sulfur or cold rolled steel.
   H. 7 Iron powder and mineral. Heavy tanks, etc.
   I. 8 Iron powder and low hydrogen.

TEMPERATURE DATA



TEMPERATURE DATA

The right side of this chart indicates the welding/soldering range for iron and steel at various temperatures.

The red color begins to increase in intensity from about 950° to approximately 1600°. In this range the colors tend to get brighter as the temperature is increased. The left side of the chart indicates the melting point for different kinds of metal.

Steel should be preheated to prevent cracks from occurring due to uneven stresses formed by welding. The range at which preheating should take place depends upon the carbon content but preheating should be done at temperatures from 100° up to about 800°. This is still called a black heat range.

From 300° to 700° is considered a blue brittle range. Steel should not be peened or worked between these temperatures since they are more brittle in this temperature range than they are above this temperature or below it.

From the temperature of about 1700° for low carbon steel down to about 1400° for steel with .9% carbon is called a transformation range. In this transformation range, steels undergo internal atomic changes that affect the properties of the steel.

Stress relieving is a process that consists of heating the steel until the lower transformation temperature is reached and then holding it long enough to relieve stresses that are locked up in the metal and then cooling it very slowly. For stress relieving the temperature should not be increased above about 1350°.

It is important to remember the melting temperatures of various metals as indicated in the left-hand scale. Notice that aluminum melts at slightly above 1200° and you must remember that aluminum oxide melts at a higher temperature than this, so the oxide must be removed before good welding of aluminum can take place.

TYPE OF ELECTRODE COATING - CURRENT TYPE

AWS NO.	TYPE OF COATING	CURRENT**
E 6010*	HIGH CELLULOSE SODIUM	DC+
E 6011	HIGH CELLULOSE POTASSIUM	DC+ AC
E 6012	HIGH TITANIA SODIUM	DC- AC
E 6013	HIGH TITANIA POTASSIUM	DC+ DC- AC
E 6020	HIGH IRON OXIDE	DC+ DC- AC
E 6027	IRON POWDER, IRON OXIDE	DC+ DC- AC
E 7014	TITANIA IRON POWDER	DC+ DC- AC
E 7015	LOW HYDROGEN SODIUM	DC+
E 7016	LOW HYDROGEN POTASSIUM	DC+ AC
E 7018	IRON POWDER, LOW HYDROGEN	DC+ AC
E 7024	IRON POWDER, TITANIA	DC+ DC- AC
E 7028	IRON POWDER, LOW HYDROGEN	DC+ AC

** DC+ = REVERSE

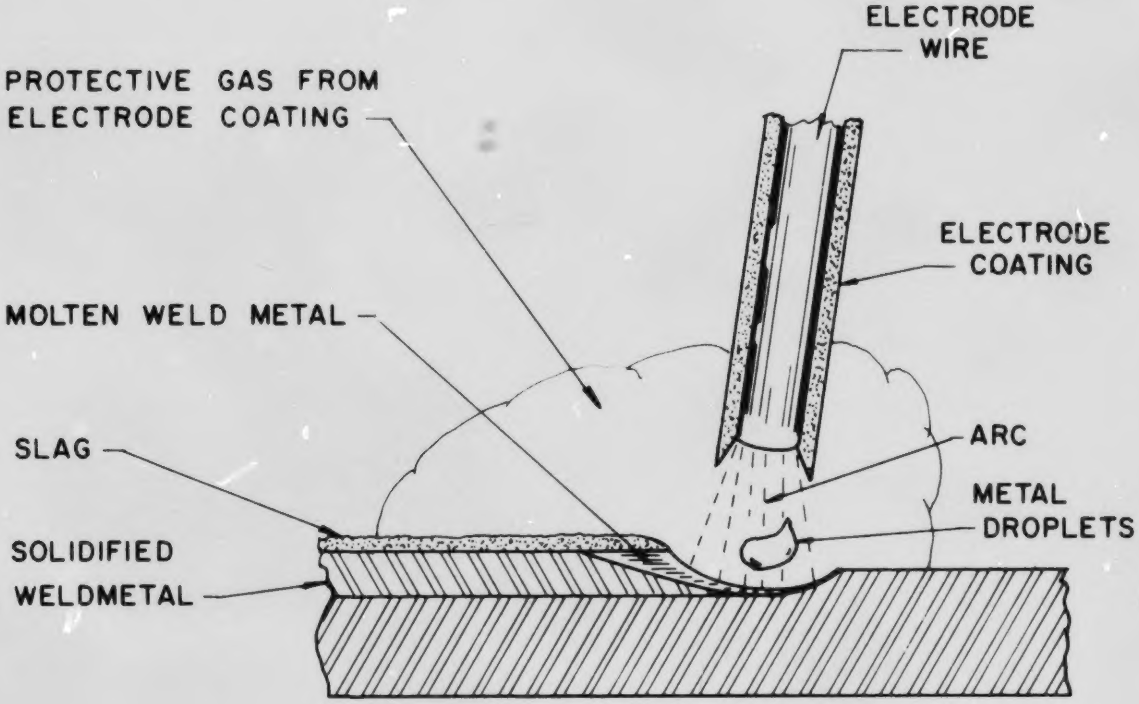
DC- STRAIGHT

II-H-1-43

TYPE OF ELECTRODE COATING - CURRENT TYPE

This chart was adapted from information available from AWS classification data.

GAS SHELDED METAL - ARC WELDING

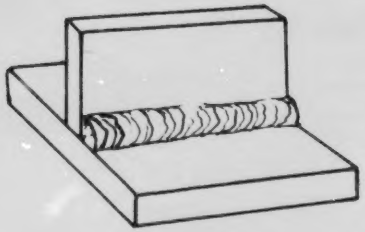

ELECTRODE WIRE
PROTECTIVE GAS FROM ELECTRODE COATING
ELECTRODE COATING
MOLTEN WELD METAL
ARC
SLAG
METAL DROPLETS
SOLIDIFIED WELDMETAL

GAS SHIELDED METAL-ARC WELDING

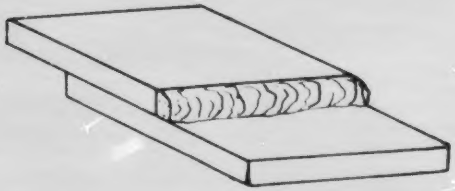
This illustration shows the metal being transfered from the electrode to the base metal through the arc. As the electrode coating disintegrates under the heat of the arc, a protective gas is formed. This protective gas, shields the molten droplets and the weld metal pool from the atmosphere. The electrode coating melts to form a slag over the top of the solidified weld metal.

This illustration shows the electrode tilted at about 15° from vertical. Whenever possible, weld from the left to the right (if you are right handed). This enables you to see clearly what you are doing. If you concentrate your attention on the action, where the arc is melting the base metal, you can observe the depth of penetration that is taking place.

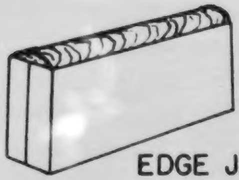
COMMON WELDS



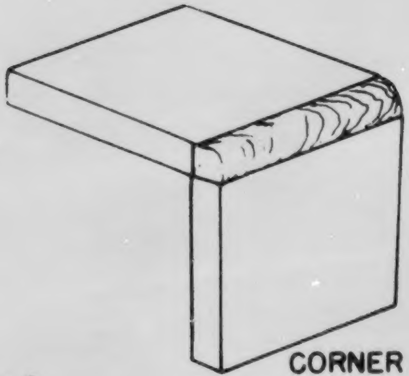
TEE (FILLET) JOINT



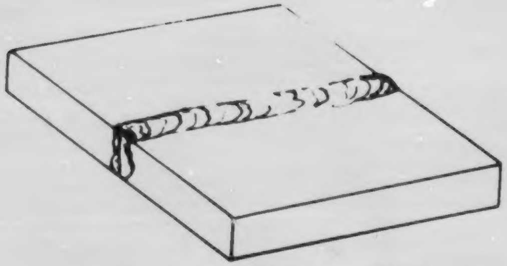
LAP JOINT



EDGE JOINT



CORNER JOINT



BUTT JOINT

IJ-H-1-47

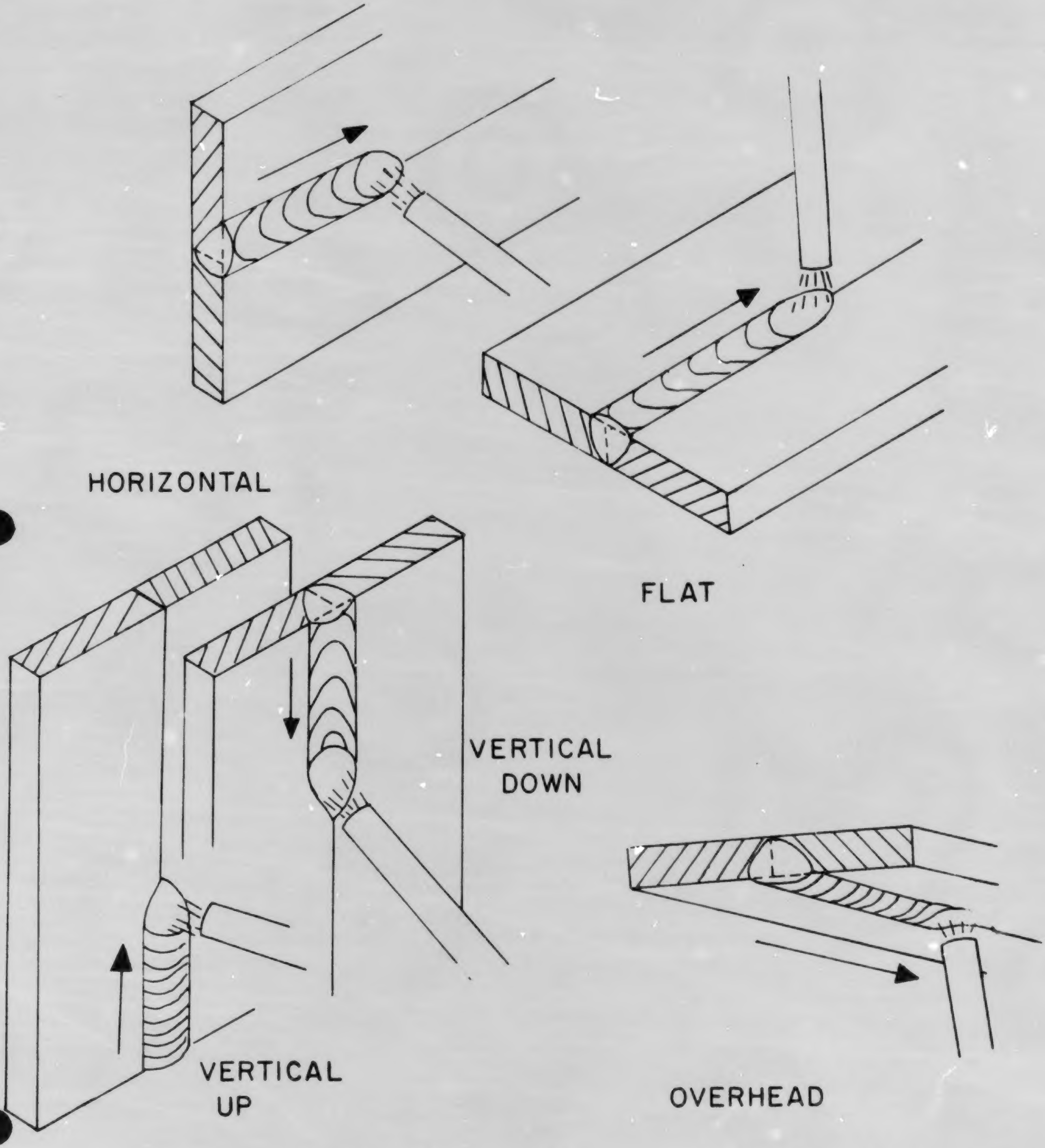
COMMON WELDS

In the design of new equipment and the subsequent fabrication of metal to build this equipment the most common welds are shown here.

Variations of these welds are also used in maintenance and repair of equipment.

In practicing arc welding, you should practice making these types of welds and variations of them because most welding applications will include these five common welds, or some slight variations of them.

FOUR BASIC WELDING POSITIONS


HORIZONTAL
FLAT
VERTICAL DOWN
VERTICAL UP
OVERHEAD

FOUR BASIC WELDING POSITIONS

The four basic welding positions are shown here. In almost every instance the flat or down-hand position is best if it is possible to weld in this position.

In modern factories large positioners are used to enable the welders to work in a down-hand or flat position to improve the quality of the finished product.

Maintenance weldors and farmers who must repair equipment on the job find it necessary to use the horizontal, vertical and overhead weld frequently.

TEACHER'S KEY

SAMPLE WELDING SAFETY TEST

PART [illegible] ARC WELDING SAFETY

Name____________________

Directions: Mark each statement T for true or F for false

__F__ 1. Infrared rays are given off by arc welders.

__F__ 2. Safety glasses should not be worn when welding because heat causes them to fog up.

__F__ 3. Helmets should have a number 5 shade lens for arc welding.

__F__ 4. Welders should wear rubber gloves to insulate themselves from shocks by the welder.

__F__ 5. Welding cables must be oiled frequently to prevent them from drying out.

__F__ 6. An open container of solvent or gas should be kept close to the welding area to be used to clean welds.

__T__ 7. Floors in the welding area should be kept dry to reduce electrical shocks.

__F__ 8. Electrode holder connections should be loose to allow easy removal for inspection.

__T__ 9. To be properly grounded, the welding cables must make a complete electrical circuit.

__T__ 10. CO_2 extinguisher or sand could be used for quick fire protection.

__F__ 11. Welding shirts should have short sleeves to keep the person welding from getting too hot.

__F__ 12. Hot metal is easily handled by just using gloves.

__F__ 13. If your clothing catches on fire, run quickly in circles to blow the fire out.

__T__ 14. Welders must pay close attention to safety procedures at all times to avoid injury.

__T__ 15. Severe shock causes muscle spasms.

__T__ 16. Burns are a major hazard of welding.

_F_ 17. NAMA inspects welders for safe construction.

_T_ 18. Injuries received from shock reactions are often more serious than the shock itself.

_F_ 19. Welding cables are unharmed by carts or wheels.

_T_ 20. Safety glasses are needed to protect eyes when chipping slag and grinding.

_F_ 21. Most eye injuries are not serious and do not require a doctor's attention.

_T_ 22. Welders need to wear leather gauntlet gloves when welding.

_F_ 23. Class B fires are on wood, paper, and other solid materials.

_F_ 24. Most containers can be welded without precautions.

_T_ 25. Zinc oxide is toxic to humans when inhaled.

TEACHER'S KEY

SAMPLE TEST QUESTIONS

PART II WELDING PRINCIPLES

Name____________________

T F 1. Paper and pencil are required daily for this class?

C 2. The definition of welding is the ____________ of two pieces of metal using a heat process.

A. Adhesion
B. Fastening
C. Fusion
D. Gluing
E. None of the above.

B 3. When was the electric arc discovered?

A. early 1700's
B. early 1800's
C. early 1900's
D. 1920's
E. none of the above

D 4. Which of the following does not describe the tungsten insert gas welding process?

A. nonconsumed electrode
B. shielding gas
C. used on aluminum
D. uses spools of electrode wire
E. all of the above

E 5. Which of the following is not a classification for welders?

A. current
B. line voltage
C. power sources
D. service
E. all of the above

[✓ T] F 6. A switch is used to select amperages on a Lincoln AC 225 welder.

[✓ T] F 7. Load unbalances on power supply wiring is a disadvantage of transformer welders.

A 8. Duty cycle is the percentage of a ______________ minute period that a welder can operate at a given setting.

A. 10
B. 20
C. 30
D. 60
E. none of the above

A 9. Which of the following is not a function of the flux coating?

A. prevents the electrode from rusting
B. protects molten metal from the atmosphere
C. removes impurities in a slag
D. stabilizes the arc
E. none of the above

C 10. What increment is used for minimum tensile strength?

A. 100
B. 1000
C. 10,000
D. 100,000
E. none of the above

D 11. Which of the following is not a type of flux coating?

A. cellulose
B. hydrogen
C. iron
D. magnesium
E. titania

T F 12. E6012 electrodes have medium penetration.

B 13. Which of the following is not a principal hazard of welding?

A. burns
B. cuts, bruises and broken bones
C. electrical shock
D. eye injuries
E. fires

T F 14. Cotton, gauntlet gloves should be used for welding.

T F 15. All shop work must have the instructor's approval or direct supervision.

B 16. Which of the following are the two most basic welding processes in agriculture shops?

A. arc and MIG
B. arc and oxyacetylene
C. arc and spot welding
D. arc and TIG
E. none of the above

B&D 17. Which two of the following men developed the first electrode?

A. KeMeritans
B. Kjellberg
C. Sir Humphrey Davy
D. Slavinoff
E. none of the above

A 18. Which of the following are the categories for the current classification of welders?

A. AC and DC
B. AD and BC
C. AD and DC
D. CA and CD
E. none of the above

[✓ T] F 19. A moving coil or shunt can give a transformer continuous or stepless amperage.

T [✓ F] 20. Electrodes with special coatings to ignite easily are an advantage of AC transformer welders.

C 21. Which of the following reasons is not why electrode labelling is important?

A. AC welders require electrodes with special coatings.
B. Different electrodes have different properties for certain jobs.
C. Electrodes from different companies are very different.
D. Some DC electrodes require a certain polarity.
E. all of the above.

A 22. Three of the following weld tests would give a minimum tensile strength of 60, which does not give a minimum tensile strength of 60?

A. 59,000
B. 61,000
C. 65,000
D. 69,000
E. all of the above

23 thru 31 Match the correct type of coating number used on electrodes with the coating it represents.

B	high cellulose with potassium	A.	0
E	high titania with iron powder	B.	1
D	high titania with potassium	C.	2
C	high titania with sodium	D.	3
H	iron powder with iron oxide	E.	4
I	low hydrogen with iron powder	F.	5
G	low hydrogen with potassium	G.	6
F	low hydrogen with sodium	H.	7
A	refer to previous digit	I.	3

T [✓ F] 31. E6013 electrodes have deep penetration.

[✓ T] F 32. NEMA inspects welders for safe design and construction.

D 34. Who must wear safety glasses or goggles in the shop at all times?

A. all instructors
B. all students
C. all visitors
D. all of the above

E 35. Which of the following is an advantage of transformer welders?

A. high electrical efficiency
B. low cost and low maintenance
C. low noise level
D. small and light in size
E. all of the above

C 36. Which of the following does not describe welding cables?

A. insulate with rubber
B. made with fine strands of copper wire
C. never need to be inspected
D. usually are a No. 2 size
E. all of the above

C 37. Moving the electrode too fast will cause;

A. the electrode to stick.
B. excessive splattering.
C. narrow bends.
D. wide bends.

A 38. Too low a current will cause;

A. poor penetration
B. splattering
C. under-cutting
D. wide beads

Essay

39. A good bead depends on what four factors?

40. Briefly outline the procedure to follow when preparing metal for welding and striking an arc.

UNIT H: AGRICULTURAL MECHANICS

PROBLEM AREA: DEVELOPING OXY-ACETYLENE WELDING SKILLS

SUGGESTIONS TO THE TEACHER:

This unit is designed to provide students with those skills necessary to become proficient in basic oxy-acetylene welding. The recommended time for teaching this unit is during the winter when outside activities are at a minimum. The estimated time for teaching this unit is two to four weeks. Approximately five to seven days of this time should be devoted to classroom study. The remaining time should be used for hands-on experience. Before teaching this problem area the teacher should:

1. Have available the required references and appropriate teaching materials.

2. Duplicate those materials in this unit appropriate to local needs.

3. Check and test all equipment to be used in the welding shop.

4. Obtain and have on hand the following:
    a. necessary safety clothing
    b. adequate supplies of welding gas
    c. necessary welding and cutting equipment
    d. a variety of welding and brazing rod and flux

5. The instructor must also arrange for a reliable source of scrap metal.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts this problem area to his/her local situation.

CREDIT SOURCES:

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The teacher's guide, worksheets, and transparency discussion guide were developed by Mike Robertson, Vocational Agriculture Instructor, Chrisman High School, Chrisman, Illinois and by Jerry Pepple, Department of Vocational and Technical Education, University of Illinois. The transparency masters were prepared by Vocational Agriculture Service, University of Illinois. Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Agricultural mechanics

II. Problem area: Developing oxy-acetylene welding skills

III. Objectives: At the close of this problem area students will:

1. Understand the importance of safe practices in the use of oxy-acetylene welding equipment.
2. Be able to safely turn tanks on and off using the proper sequence of procedures.
3. Dress properly when using the oxy-acetylene equipment.
4. Be able to identify the differences between mild steel fusion welding, bronze welding (brazing), and soldering.
5. Be able to safely service the oxy-acetylene equipment including the following:
   a. changing tanks
   b. testing for leaks
   c. changing and cleaning torch tips
6. Be able to properly prepare and correctly perform the following welds in a flat position using one-quarter inch thick or thinner metal:
   a. mild steel fusion butt weld
   b. bronze butt weld
   c. mild steel fusion fillet weld
   d. bronze fillet weld
   e. mild steel fusion lap weld
   f. bronze lap weld
   g. mild steel fusion edge weld
   h. bronze edge weld
   i. mild steel fusion corner weld
   j. bronze corner weld
7. Be able to use a cutting torch to cut a straight line and a curve in metal one quarter to one half inch thick.

IV. Suggested interest approaches:

1. Tour the shop welding area and identify the parts of the acetylene welder and various items of equipment.
2. Repair some small item as a demonstration.
3. Discuss employment prospects for a welding career.
4. Have a local welder come in to discuss the advantages and disadvantages of a career in welding.

5. Discuss the importance of welding skills in the many areas of employment in agriculture.

V. Anticipated problems and concerns of students:

1. What are the proper safety precautions when welding?

2. Why learn to oxy-acetylene weld when I want to learn to arc weld?

3. Will we get to use the cutting torch?

4. What is the difference between welding and brazing?

5. Is there enough equipment for everyone to work?

6. What is the difference between arc welding and oxy-acetylene welding?

7. What kind of gases do you use?

8. What safety practices should I follow when servicing oxy-acetylene equipment?

9. What are the different types of welds?

10. How should I dress when welding?

11. What is soldering? How does it differ from welding?

12. What steps are involved in cutting a piece of metal?

13. What are the parts of a welder?

14. How should hoses be cared for and stored?

15. What causes a backfire?

16. How can I test for leaks?

VI. Suggested learning activities and experiences:

1. Bring a welding rig into the classroom or use VAS Unit 3001a as an aid in completing and discussing Worksheet 1 and transparency on identification (or substitute VAS Slidefilm 454a if time allows).

2. Distribute Worksheet 2. Have students complete Worksheet 2 using VAS Unit 3001a as a reference (if only a particular skill will be covered, use only applicable parts).

3. Demonstrate turning tanks off and on. Allow students an opportunity to do this under instructor supervision.

4. Use transparencies and discussion guides to lead a discussion on safety equipment and clothing (substitute VAS Slidefilm 455a if time allows.)

5. Use transparencies to demonstrate the different types of welding flames.

6. Use transparencies to illustrate differing types of welds.

7. Use a welding rig to illustrate differing types of welding flames.

8. Incorporate a shop demonstration and discussion on flux and welding rod with a demonstration on set-up and procedures in making a fusion butt weld.

9. Demonstrate and discuss tip selection and cleaning.

10. Demonstrate lighting and adjusting the cutting torch.

11. Demonstrate making a cut, use Job Sheet 3.

12. Demonstrate other types of welds and allow students to practice and complete these welds, use Job Sheets 1, 2, and 4.

VII. Application procedures:

1. The main purpose of this unit is to allow students to develop basic oxy-acetylene welding skills. The unit should stress welding safety and welding procedures.

2. Any or all of the skills may be taught. However, there is a great deal of information carryover involved and if a student can master one of these skills the others will come more easily.

3. Students must be given adequate shop time in order to develop their welding skills.

4. If used in conjunction with a unit on arc welding, specific safety procedures for each unit should be covered.

VIII. Evaluation:

1. Worksheets and tests.

2. Evaluation of welds (see attached welding evaluation sheet).

3. Evaluation of welding safety procedures.

4. Evaluation of shop conduct.

IX. References and aids:

1. Vocational Agriculture Service, University of Illinois
    a. VAS Unit 3001a
    b. VAS Slidefilms 454a, 455a, 456a, 471, 473, 474
2. Worksheets
3. Job Sheets
4. Transparencies

INFORMATION SHEET

WELD EVALUATION SCORE SHEET

Name______________________________ Period__________

Instructor______________________________

Type of Weld______________________________

Assignment Number______________________________

Criteria	Points Possible	Points Earned
1. Bead is of uniform height and width, centered over separation.	2	______
2. Uniform ripples indicating proper speed, slag easily removed.	2	______
3. Proper degree of penetration.	2	______
4. Weld runs full length of piece, both ends properly connected.	2	______
5. Strength.	2	______
TOTAL	10	______

STUDENT WORKSHEET 1
EQUIPMENT FOR WELDING

____ 1. Acetylene gas is a compound of carbon and hydrogen which is manufactured from calcium carbide. It is:
A. a flammable gas that burns only when mixed with carbon dioxide.
B. flammable only after it has been stored 90 days.
C. a highly flammable gas and cannot be safely stored in hollow cylinders.
D. a gas that is stored in small cylinders at 2500 pounds pressure.

____ 2. Acetylene cylinders contain:
A. 250-275 pounds of pure acetylene gas.
B. acetylene absorbed by ketone.
C. a porous material to absorb the shock if the cylinder is dropped.
D. acetone and as the gas is used more comes out of solution.

____ 3. The standard pressure of a full oxygen cylinder is:
A. 2000 psi at 100° F.
B. 2200 psi at 70° F.
C. 3000 psi at 70° F.
D. 2500 psi at 0° F.

____ 4. The hoses used with a welding outfit are a:
A. red hose for oxygen and a black hose for acetylene.
B. green hose for oxygen and a black hose for acetylene.
C. green hose for oxygen and red hose for acetylene.
D. black hose for oxygen and a red hose for acetylene.

____ 5. In addition to different colors, the hoses have different connections. The oxygen hose has:
A. right-hand threads with grooved nuts and acetylene has left-hand threads.
B. right-hand threads and acetylene has right-hand threads with grooved nuts.
C. left-hand threads and acetylene has left-hand threads with grooved nuts.
D. right-hand threads and acetylene has left-hand threads and grooved nuts.

____ 6. The mixing chamber for the gases is called a blow pipe and the proportions of each gas can be controlled by adjusting:
A. the cylinder opening.
B. the cylinder pressure.
C. the blow pipe valves.
D. the size of tips.

____ 7. Which of the following statements concerning goggles is or are not true?

A. They protect the eyes from sparks and bits of metal.
B. They shield the eyes from bright light.
C. They prevent irritation caused by drying effect of heat.
D. They need not be worn to watch someone else weld.

____ 8. Which of the following statements is not true?

A. Gauntlet gloves of leather should be worn when welding or cutting.
B. Gloves should be free from oil or grease.
C. A friction lighter is used to light the blowpipe.
D. A match or cigarette lighter is a safe substitute for a friction lighter.

____ 9. Which of the following should be used to clean soot, slag, or dirt from the blowpipe tip?

A. Small nails.
B. Steel wires.
C. Small drills.
D. Tip cleaners.

____ 10. To provide a good safe work area and to prevent rapid conduction of heat away from the welding area, the table should have:

A. a metal frame with a fire-brick top.
B. a metal frame with a steep top.
C. a metal frame with a wooden top.
D. a wooden frame with a metal top.

STUDENT WORKSHEET 2

OXY-ACETYLENE WELDING

Answer the following questions using VAS Unit 3001a as a guide:

Part I. Equipment needed.

1. Acetylene is a fuel gas made of ______________ and __________.
2. The two basic principles upon which the oxy-acetylene process is built are:
   a.
   b.
3. Acetylene can be stored at pressures up to 250 psi only if mixed with ____________________.
4. The function of the regulator is to ____________________________ ____________________.
5. Oxygen hoses are always __________, while acetylene hoses are always ______________ in color.
6. As further protection, oxygen equipment has ______________ handed threads, while acetylene connections always have ________ handed threads.
7. Two functions of the blow pipe are:
   a. ____
   b. ____
8. The reasons for wearing safety goggles are because they perform three important functions which are:
   a. ____
   b. ____
   c. ____
9. Gauntlet type gloves need to be worn to protect ________________ from high heat.
10. Why should a friction igniter (striker) be used to light the torch rather than a match or cigarette lighter? __________________
    ____

11. List four items that can cause a tip opening to clog and require a tip cleaner to be used:

a. ____________________
b. ____________________
c. ____________________
d. ____________________

Part II. Connecting and testing equipment.

1. Why should the oxygen valve be "cracked" before connecting the regulator? ____________________

2. Why should brass fittings not be over tightened? ____________________

3. List the steps for connecting the oxygen equipment:

a. ____________________
b. ____________________
c. ____________________
d. ____________________
e. ____________________

4. List the steps for connecting the acetylene equipment:

a. ____________________
b. ____________________
c. ____________________
d. ____________________

5. Acetylene pressure should always be set at __________ psi.

6. Oxygen pressure settings will vary from _____ psi to _____ psi.

7. The testing procedure for leaks required applying _____ with a paint brush and watching for ____________________.

Part III. Lighting the blowpipe and adjusting the flame.

1. The steps for lighting the blowpipe are:

a. ____________________
b. ____________________
c. ____________________

2. The three different zones of the flame are:

a. ____________________
b. ____________________
c. ____________________

3. Which types of flames are used for what purposes?

a. ______________________________
b. ______________________________
c. ______________________________

4. The seven steps for shutting down the equipment are:

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________
f. ______________________________
g. ______________________________

Part IV. Welding Safety.

1. Safe cylinder storage includes:

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________

2. Oxygen valves should always be ____________ before moving.

3. Always use ____________ to open and close acetylene cylinders.

4. To prevent fires, __________ and grease should always be kept away from welding equipment.

5. The proper shades for welding goggles are:

a. Cutting ______________________________
b. Fusion welding ______________________________
c. Brazing ______________________________

6. When welding or cutting galvanized metal a noxious gas called __________________ is formed. Illness from this gas will last ______________ hours.

7. List five safety rules concerning clothing:

a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________

8. Class A fires concern what materials? ______________________________
____

9. Class B fires concern what materials? ______________________________
____

10. What special precautions should be taken when welding over wooden floors, in truck beds, or wagon beds? ________________.

11. Two precautions to be taken when cutting tanks or closed containers are:

a. ____
b. ____

12. What causes a backfire?

a. ____
b. ____

13. What is a flashback? ______________________________________
____

14. Why should oxygen not be used to clean-off clothes?
____

15. Review three important points on regulators.

a. ____
b. ____
c. ____

Part V. Cutting with the oxyacetylene equipment.

1. Cutting with oxy-acetylene equipment is the same as ______________ only it occurs at a much faster rate.

2. The first step in cutting is to connect a ______________________ to the blowpipe in place of the welding tip.

3. When starting to cut, the oxygen-cutting valve-lever should be pushed down and the oxygen pressure adjusted to __________psi.

4. Acetylene pressure should be ________psi.

5. The oxygen preheat flames should be adjusted to neutral or ____.

6. When cutting, the proper speed is ______________________________
____.

7. What happens when the torch is moved too slowly? ____.

8. What happens when the torch is moved too fast? ____.

9. List the four steps involved in cutting or piercing a hole.

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________

10. What special steps should be taken when cutting cast iron?

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
   e. ____________________

Part VI. Bronze Welding (brazing).

1. ____________ out of ten repairs can be satisfactorily completed using a bronze weld.

2. Bronze welding alloy is made chiefly of ______________ and ______________.

3. The melting point of this alloy is about ____________ °F.

4. In order to get a clean surface, metal must be ____________ and ____________ must be used to keep metal clean.

5. When brazing, the flame should be adjusted to ______________________.

6. When preparing to make a bronze butt weld, the two pieces should be placed side by side with the edges ______ inches apart on one end and ______ inches apart on the other end. What are the reasons for this difference in the size of the gaps?

7. When brazing pieces over ¼ inch thick, the edges should be ______________.

Part VII. Fusion Welding.

1. Fusion welding is a) easier, b) harder than brazing.
2. What is the basic activity to be performed in fusion welding?
____
____
3. What happens when you advance the flame too fast?________________
________________________________. Too slowly?________________
____
4. Why is filler rod added to a fusion weld?________________________
____
5. What are the steps for fusion welding thicker metal?

   a.

   b.

   c.

   d.

JOB SHEET 1

BRONZE WELDING BEADS

OBJECTIVES:

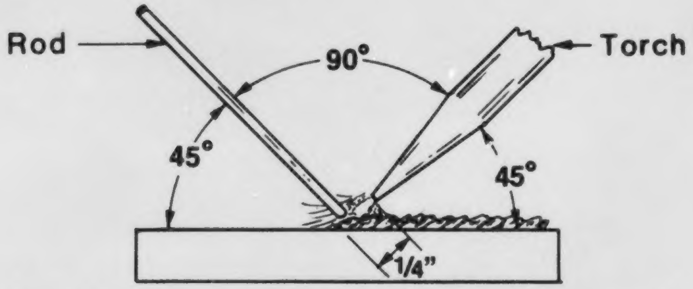
1. To develop the ability to select the proper welding equipment for bronze welding.
2. To develop the ability to properly adjust the acetylene welder and properly prepare metal for bronze welding.
3. To develop the ability to explain and demonstrate the correct procedure to use in running bronze welding beads.

MATERIALS:

1. Brazing rod 1/8" or 3/16" diameter.
2. Flux.
3. Acetylene welder.
4. 3" plate steel 3/16" or 1/4" thick.

PROCEDURE:

1. Select medium sized tip for welder.
2. Set regulators to about 5 lbs of oxygen and acetylene.
3. Clean metal by grinding or wire brushing to remove rust, scale, and oil.
4. Light blowpipe and adjust the flame to slightly oxidizing.
5. Hold blowpipe so nozzle forms a 45 degree angle to the surface of the metal and is about 1/4" above the surface. Heat to a dull red.
6. Touch end of rod to surface. The bronze should spread out evenly if it is at the proper temperature. Hold the rod about 90 degrees to the torch.



7. Move the flame in a series of horizontal arcs or ovals and the rod back and forth across the puddle.

QUESTIONS:

1. What operating pressure did you use for oxygen? ________________ acetylene?____________________.
2. What tip size did you use? ____________________
3. What is meant by "tinning" the surface? ________________________
4. What is the melting point of bronze? ________ Steel? __________

OBSERVATIONS: Describe the technique used to hold the torch and rod when brazing. What did you do when the bronze was not hot enough? When it was too hot?

APPLICATION: Describe how to run a bronze weld and how this skill can be used in your S.O.E.P.

JOB SHEET 2

FUSION BUTT WELD

OBJECTIVES:

1. To develop the ability to select the proper welding equipment for fusion welding:
2. To develop the ability to properly adjust the acetylene welder and properly prepare metal for fusion welding.
3. To develop the ability to explain and demonstrate the correct procedure to use in fusion butt welding.

MATERIALS:

1. Two pieces of steel 1/8" thick.
2. 1/8" steel welding rod.
3. Welder with small or medium sized tip.

PROCEDURE:

1. Adjust regulators to about 5 pounds of oxygen and acetylene.
2. Clean metal by grinding or wire brushing to remove rust, scale, and oil.
3. Light blowpipe and adjust flame to neutral.
4. Tack weld ends by holding the rod in the outer part of the flame envelope about 1/4 inch from the edge of the metal. As two spots of molten metal begin to form, add some filler metal from the rod to bridge the gap.
5. Play the flame on the first tack weld and remelt a puddle. Add metal from the rod and carry the puddle along. Be sure both pieces are melting and mixing.
6. Move the flame in a circular motion to keep both pieces melted. Hold the flame's inner core about 1/4" from the metal. Move the rod in and out of the puddle so you keep adding filler metal.
7. Check bead height, width, ripple, and penetration.

QUESTIONS:

1. What are the three parts of the acetylene flame ____________? Which one is the hottest? ____________.
2. How did you change from one flame to another? ____________
   ____
3. Which tank valve is turned on all the way? __________ Why? ____________
4. Why is the other valve not turned on all the way? ____________
   ____

OBSERVATIONS: Describe the major differences between bronze welding and fusion welding? Which is easier for you?

APPLICATION: Relate how this skill can be used to benefit your S.O.E.P.

JOB SHEET 3

CUTTING STEEL

OBJECTIVES:

1. To develop the ability to select the proper welding equipment for cutting steel.
2. To develop the ability to properly adjust the acetylene welder and properly prepare metal for cutting.
3. To develop the ability to explain and demonstrate the correct procedure to use in cutting steel.

MATERIAL:

1. Welder with cutting attachment.
2. Steel plate about ¼" to ½" thick.

PROCEDURE:

1. Select proper cutting tip according to thickness of steel.
2. Set regulators at about 5 pounds for acetylene and about 20 pounds for oxygen.
3. Light and adjust flame to neutral.
4. Hold tip pendendicular to metal and keep the inner-cones about 1/8" above the metal. Heat the metal in one spot until it turns a bright red color.
5. Slightly angle the torch so the flame leads the cut and depress the oxygen lever and move slowly and evenly along the cutting line.

QUESTIONS:

1. How do you readjust the flame for cutting thin metal? ____

2. What tip size did you use? ______________

3. What pressure did you use for oxygen? ____________ Acetylene? ________

4. How can you prevent a ragged appearance on the cut edge? ____ ____

5. What happens if the blowpipe is moved too fast? ____________

OBSERVATIONS: What technique was used to light and adjust the cutting flame? How can you make sure you cut a straight even line?

APPLICATION: What advantages and benefits will this skill have toward your career goals and S.O.E.P?

JOB SHEET 4

HARDFACING STEEL

OBJECTIVES:

1. To develop the ability to select the proper welding equipment for hardfacing steel.
2. To develop the ability to properly adjust the acetylene welder and properly prepare metal for hardfacing.
3. To develop the ability to explain and demonstrate the correct procedure to use in hardfacing.

MATERIAL:

1. 1/8" or 3/16" steel plate.
2. Medium to large welding tip.
3. Tube Stoodite hardfacing rod.

PROCEDURE:

1. Clean the metal to be hardfaced by grinding to remove scale and oil.
2. Mark the area to be hardfaced with soapstone.
3. Set the regulators to about 5 pounds each of oxygen and acetylene.
4. Light and adjust the flame until it is carburizing. The feather should be about 2½ times as long as the inner core.
5. Heat a spot by holding the inner core about 1/8 inch above the work until the metal begins to sweat.
6. Move the flame back slightly and bring the end of the rod between the inner core and the heated surface.
7. Hold the rod so it just touches the sweating surface and a puddle of molten rod forms on the surface.
8. Move the rod and flame back and forth together. As the surface sweats, rod metal will flow and spread smoothly within the flame. Use bronze-welding flux to help the rod metal flow.
9. Repeat these steps until the entire surface is covered with a thin layer of hardfacing material.

QUESTIONS:

!. What flame did you use for hardfacing? __________________ Why?

____

____

2. Did you melt the base metal? __________ Why or why not?

____

3. Did you find hardfacing easier or more difficult than fusion welding? Why? ____

____

4. How did you control the heat of the base metal when hardfacing?

OBSERVATIONS:

What special skills did hardfacing develop that were not needed for bronze welding and fusion welding? Outline the technique used for hardfacing. What precautions were used when cooling the hardfaced parts? Why?

APPLICATION:

Name or describe some situations where you feel hardfacing of materials could be done to reduce replacement costs? How can this skill benefit your S.O.E.P?

TEACHER'S KEY

WORKSHEET 1

EQUIPMENT FOR WELDING

C 1. Acetylene gas is a compound of carbon and hydrogen which is manufactured from calcium carbide. It is:
- A. a flammable gas that burns only when mixed with carbon dioxide.
- B. flammable only after it has been stored 90 days.
- C. a highly flammable gas and cannot be safely stored in hollow cylinders.
- D. a gas that is stored in small cylinders at 2500 pounds pressure.

D 2. Acetylene cylinders contain:
- A. 250-275 pounds of pure acetylene gas.
- B. acetylene absorbed by ketone.
- C. a porous material to absorb the shock if the cylinder is dropped.
- D. acetone and as the gas is used more comes out of solution.

B 3. The standard pressure of a full oxygen cylinder is:
- A. 2000 psi at 100° F.
- B. 2200 psi at 70° F.
- C. 3000 psi at 70° F.
- D. 2500 psi at 0° F.

C 4. The hoses used with a welding outfit are a:
- A. red hose for oxygen and a black hose for acetylene.
- B. green hose for oxygen and a black hose for acetylene.
- C. green hose for oxygen and red hose for acetylene.
- D. black hose for oxygen and a red hose for acetylene.

D 5. In addition to different colors the hoses have different connections. The oxygen hose has:
- A. right-hand threads with grooved nuts and acetylene has left-hand threads.
- B. right-hand threads and acetylene has right-hand threads with grooved nuts.
- C. left-hand threads and acetylene has left-hand threads with grooved nuts.
- D. right-hand threads and acetylene has left-hand threads and grooved nuts.

C 6. The mixing chamber for the gases is called a blow pipe and the proportions of each gas can be controlled by adjusting:
- A. the cylinder opening.
- B. the cylinder pressure.
- C. the blow pipe valves.
- D. the size of tips.

D 7. Which of the following statements concerning goggles is or are not true?
A. They protect the eyes from sparks and bits of metal.
B. They shield the eyes from bright light.
C. They prevent irritation caused by drying effect of heat.
D. They need not be worn to watch someone else weld.

D 8. Which of the following statements is not true?
A. Gauntlet gloves of leather should be worn when welding or cutting.
B. Gloves should be free from oil or grease.
C. A friction lighter is used to light the blowpipe.
D. A match or cigarette lighter is a safe substitute for a friction lighter.

D 9. Which of the following should be used to clean soot, slag, or dirt from the blowpipe tip?
A. Small nails.
B. Steel wires.
C. Small drills.
D. Tip cleaners.

A 10. To provide a good safe work area and to prevent rapid conduction of heat away from the welding area, the table should have:
A. a metal frame with a fire-brick top.
B. a metal frame with a steep top.
C. a metal frame with a wooden top.
D. a wooden frame with a metal top.

TEACHER' KEY

STUDENT WORKSHEET 2

OXY-ACETYLENE WELDING

Answer the following questions using VAS 3001a as a guide

Part I. Equipment needed.

1. Acetylene is a fuel gas made of carbon and hydrogen.

2. The two basic principles upon which the oxy-acetylene process is built are:

   a. Produces intensely hot flame that can melt and fuse metals.
   b. A stream of oxygen directed against metal heated to its kindling point can be used to cut and shape metal.

3. Acetylene can be stored at pressures up to 250 psi only if mixed with acetone.

4. The function of the regulator is to release gas at safe working temperature.

5. Oxygen hoses are always green, while acetylene hoses are always red, in color.

6. As further protection, oxygen equipment has right handed threads, while acetylene connections always have left handed threads.

7. Two functions of the blow pipe are:

   a. Control flow of gases to torch tip.
   b. Provide mixing chamber for gases.

8. The reasons for wearing safety goggles are because they perform three important functions which are:

   a. Protect eyes from flying sparks and bits of metal.
   b. Shield eyes from bright light produced by welding flame.
   c. Protect eyes from the drying effects of welding heat.

9. Gauntlet type gloves need to be worn to protect hands, wrists from high heat.

10. Why should a friction igniter (striker) be used to light the torch rather than a match or cigarette lighter? Prevent burns on hands and arms.

11. List four items that can cause a tip opening to clog and require a tip cleaner to be used:

    a. Dirt
    b. Soot
    c. Slag
    d. Molten metal

Part II. Connecting and testing equipment.

1. Why should the oxygen valve be "cracked" before connecting the regulator? Blow out impurities lodged in coupling.

2. Why should brass fittings not be over tightened? Stretches fitting preventing tight seal.

3. List the steps for connecting the oxygen equipment:

    a. Fasten securely.
    b. Crack valve.
    c. Connect regulator.
    d. Connect hose to regulator.
    e. Apply enough oxygen pressure to blow out the hose.

4. List the steps for connecting the acetylene equipment:

    a. Crack cylinder to remove impurities.
    b. Attach regulator.
    c. Attach hose to regulator.
    d. Attach hose to blowpipes (torch).

5. Acetylene pressure should always be set at 5 psi.

6. Oxygen pressure settings will vary from 15 psi to 55 psi.

7. The testing procedure for leaks required applying soap with a paint brush and watching for bubbles.

Part III. Lighting the blowpipe and adjusting the flame.

1. The steps for lighting the blowpipe are:

    a. Open acetylene control valve one-quarter turn.
    b. Light gas at tip with striker.
    c. Add acetylene and oxygen.

2. The three different zones of the flame are:

    a. Outer envelope.
    b. Acetylene feather.
    c Inner core.

3. Which types of flames are used for what purposes?

   a. Carburizing - Hard surfacing and high carbon steel welding.
   b. Neutral - Most mild steel fusion welding.
   c. Oxidizing - Brazing steel and cast iron.

4. The seven steps for shutting down the equipment are:

   a. Close both cylinder valves.
   b Open the blowpipe oxygen valve to drain hose and regulator.
   c. Close oxygen regulator valve (turn out until loose).
   d. Close blowpipe oxygen valve.
   e. Open torch acetylene valve to drain hoses and regulator.
   f. Close regulator by turning handwheel out until loose.
   g. Close acetylene torch valve.

Part IV. Welding Safety.

1. Safe cylinder storage includes:

   a. Store in upright position.
   b. Protect from ice, snow, and rain.
   c. Keep away from high temperature.
   d. Keep away from electrical wiring and arc welding equipment.

2. Oxygen valves should always be capped before moving.

3. Always use a wrench to open and close acetylene cylinders.

4. To prevent fires oil and grease should always be kept away from welding equipment?

5. The proper shades for welding goggles are:

   a. Cutting - #3 - #4
   b. Fusion welding - #5 - #6
   c. Brazing - #3-#4

6. When welding or cutting galvanized metal a noxious gas called zinc oxide is formed. Illness from this gas will last 24 hours.

7. List five safety rules concerning clothing:

   a. No greasy or oily clothing.
   b. No ragged clothing.
   c. Roll down cuffs and sleeves.
   d. Do not carry matches in pockets.
   e. Do not use oxygen to dust clothing.

8. Class A fires concern what materials? Wood, cloth, paper straw.

9. Class B fires concern what materials? Burning liquids -- gasoline, oils grease, paint, solvents.

10. What special precautions should be taken when welding over wooden floors, in truck beds, or wagon beds? Wet the bed.

11. Two precautions to be taken when cutting tanks or closed containers are:

    a. Clean it thoroughly - fill with water.
    b. Vent properly to prevent explosion.

12. What causes a backfire?

    a. Improper handling.
    b. Incorrect pressure setting.

13. What is a flashback? Flame disappears and burns back inside the equipment.

14. Why should oxygen not be used to clean-off clothes? Oxygen saturated clothes are extremely flammable.

15. Review three important points on regulators.

    a. Keep a gas tight connection between regulators and cylinders.
    b. Always close regulators before opening a cylinder valve.
    c. Relieve pressure on valve seats when storing for long period.

Part V. Cutting with the oxyacetylene equipment.

1. Cutting with oxy-acetylene equipment is the same as rusting only it occurs at a much faster rate.

2. The first step in cutting is to connect a cutting attachment to the blowpipe in place of the welding tip.

3. When starting to cut, the oxygen cutting valve lever should be pushed down and the oxygen pressure adjusted to 18-20 psi.

4. Acetylene pressure should be 5 psi.

5. The oxygen preheat flames should be adjusted to neutral or slightly oxidizing.

6. When cutting, the proper speed is fast enough to make a clean cut but not so fast that the base metal remelts.

7. What happens when the torch is moved too slowly? Base metal melts back together.

8. What happens when the torch is moved too fast? Incomplete cut.

9. List the four steps involved in cutting or piercing a hole.

   a. Hold tip ¼ away from surface.
   b. When area is bright red remove flame to ½.
   c. Depress oxygen lever & make small hole.
   d. Enlarge hole by lowering torch.

10. What special steps should be taken when cutting cast iron?

   a. Preheat entire piece.
   b. Begin cut adding flux.
   c. Reheat and complete cut.
   d. Reheat entire piece.
   e. Cool slowly by placing in sand, soot or cinders.

Part VI. Bronze Welding (brazing).

1. Nine out of ten repairs can be satisfactorily completed using a bronze weld.

2. Bronze welding alloy is made chiefly of copper and bronze.

3. The melting point of this alloy is about 1200° F.

4. In order to get a clean surface, metal must be polished and flux must be used to keep metal clean.

5. When brazing, the flame should be adjusted to slightly oxidizing.

6. When preparing to make a bronze butt weld, the two pieces should be placed side by side with the edges 1/8 inches apart on one end and 1/16 inches apart on the other end. What are the reasons for this difference in the size of the gaps?

   (1) Normal expansion of metal under heat
   (2) Obtain better penetration

7. When brazing pieces over ¼ inch thick, the edges should be beveled.

Part VII. Fusion Welding.

1. Fusion welding is a) easier, b) harder than brazing.

2. What is the basic activity to be performed in fusion welding? Move a puddle of molten metal at a steady rate of speed.

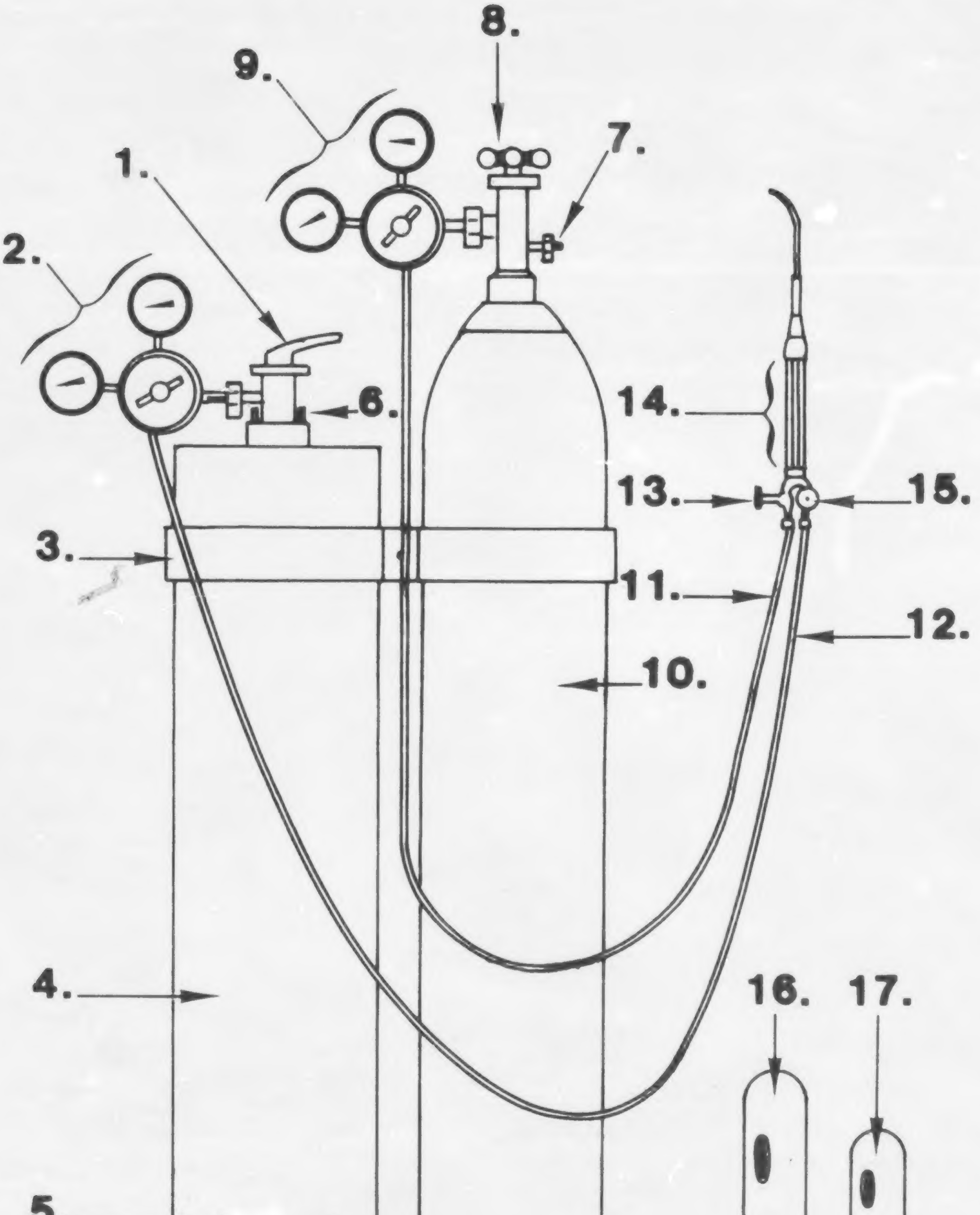
3. What happens when you advance the flame too fast? Loose puddle of molten metal bead is coarse. Too slowly? Burn too deeply into base metal or all the way through.

4. Why is filler rod added to a fusion weld? Without it weld will be thinner than base metal and weaker.

5. What are the steps for fusion welding thicker metal?

   a. Tack ends.
   b. Make root weld .
   c. Come back and put on finish weld .
   d. Continue with root weld.

OXY-ACETYLENE WELDING EQUIPMENT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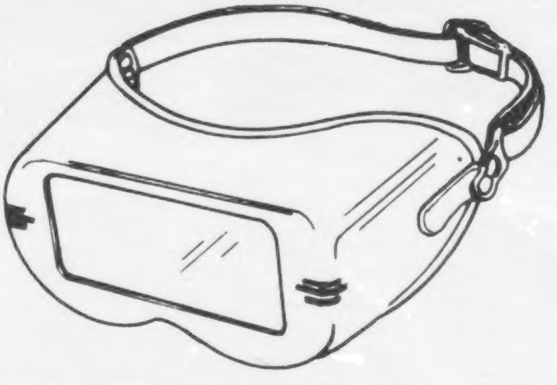
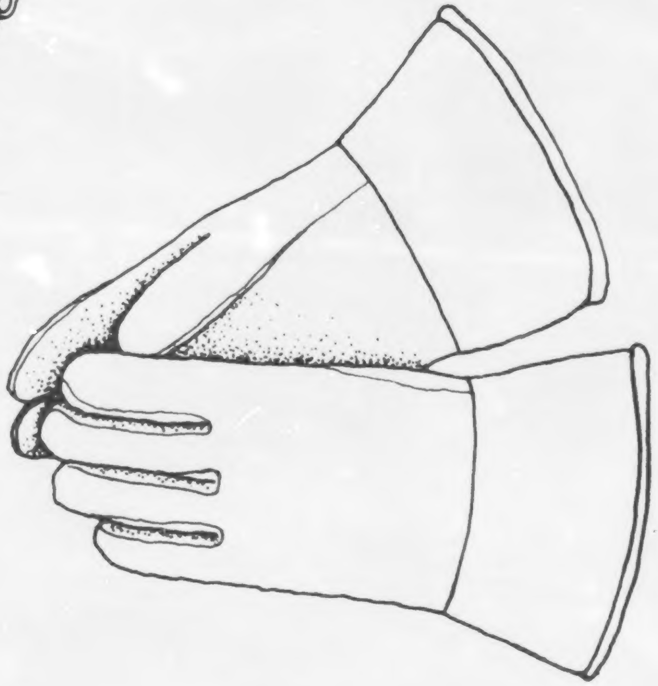
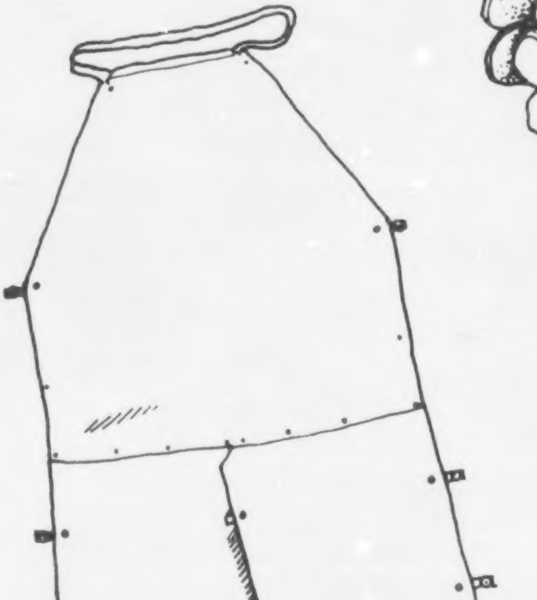
WELDING SAFETY CLOTHING



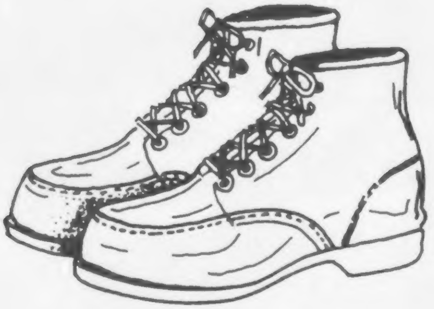
Safety goggles



Leather gloves

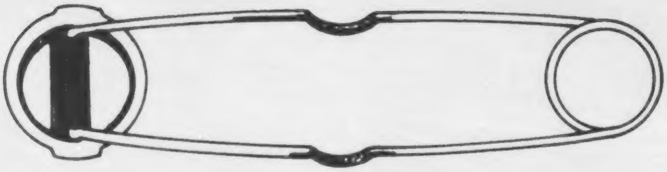


Leather apron

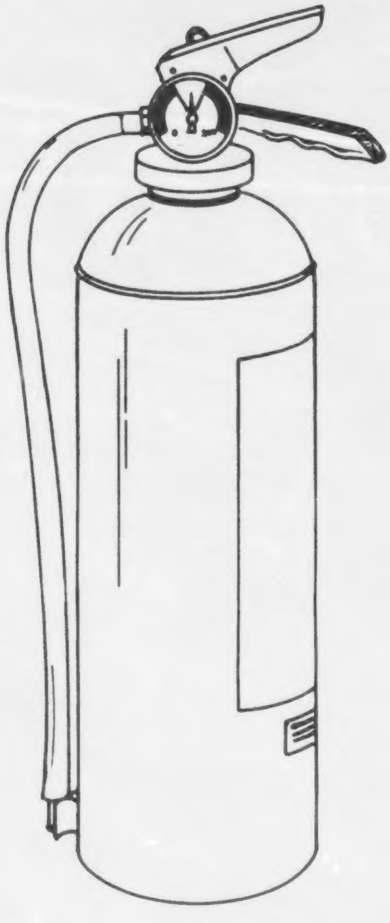


Leather boots

OTHER SAFETY EQUIPMENT

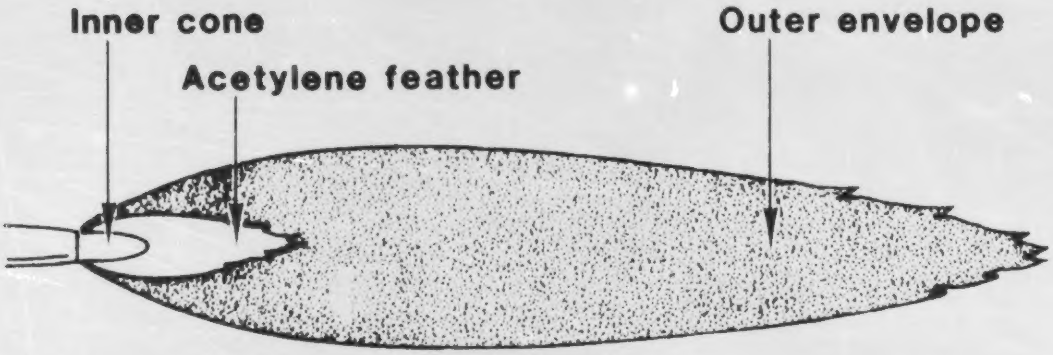


Striker (friction igniter)

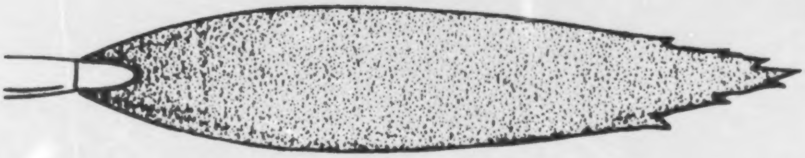


Fire extinguisher

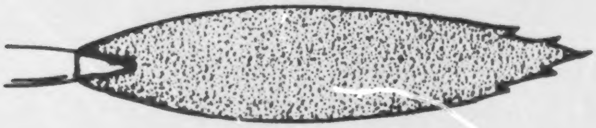
TYPES OF WELDING FLAMES


Inner cone
Acetylene feather
Outer envelope

Carburizing flame

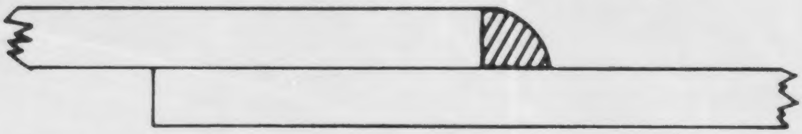


Neutral flame



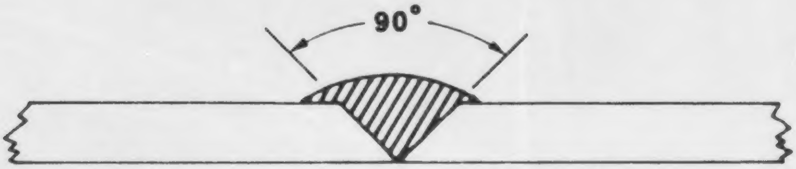
Oxidizing flame

TYPES OF JOINTS



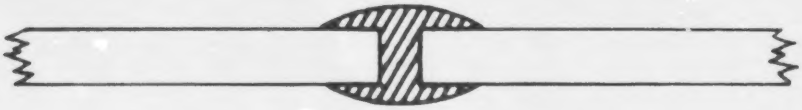
Lap Joint

over 1/8" thick



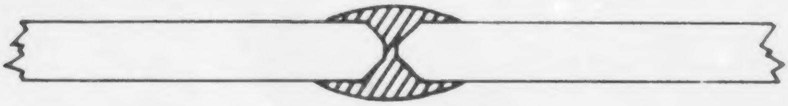
Bevel Butt Joint

up to 1/8" thick



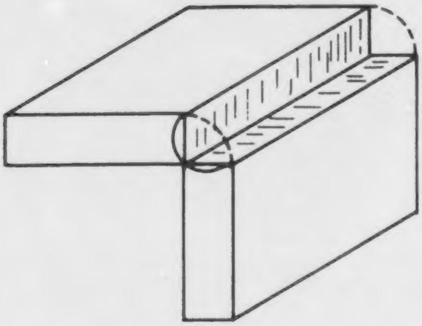
Square Edge Butt Joint

over 3/4" thick

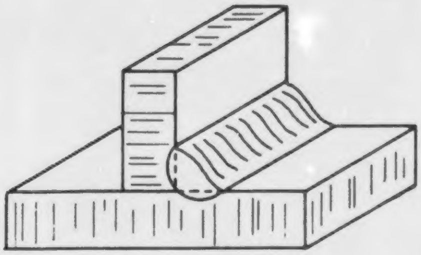


Double Bevel Butt Joint

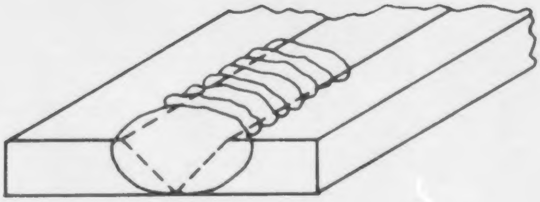
FUSION WELDING



Corner



Fillet



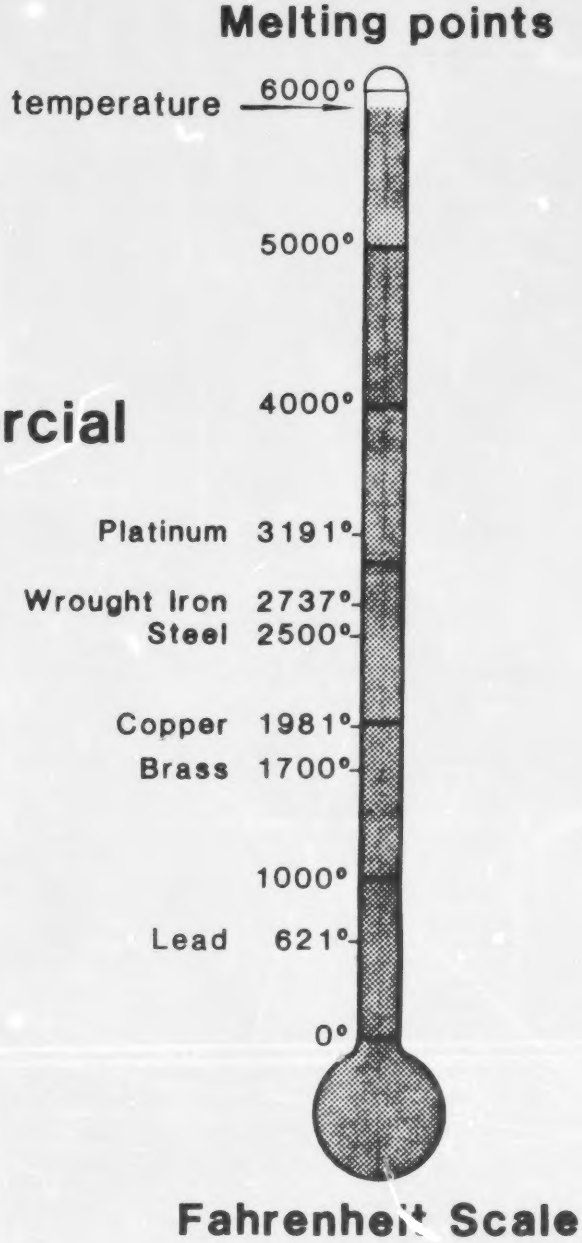
Butt (Beveled)

INDUSTRIAL TEMPERATURES

1. Oxy-acetylene flame is the hottest in industry

2. Temperature is nearly 6000°

3. Melts all commercial metals

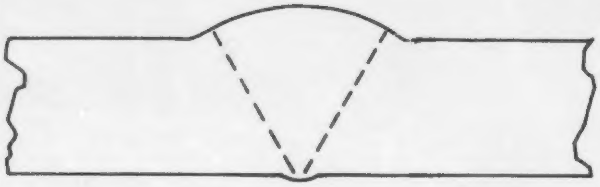

Melting points
Oxy-acetylene flame temperature
6000°
5000°
4000°
Platinum 3191°
Wrought Iron 2737°
Steel 2500°
Copper 1981°
Brass 1700°
1000°
Lead 621°
0°
Fahrenheit Scale

TO SET UP AN ACETYLENE WELDER

1. Fasten cylinders
2. "Crack" valves
3. Connect regulators
4. Loosen pressure - adjusting screws
5. Attach hoses to regulators, blowpipe
6. Attach welding head
7. Slowly open both cylinder valves
8. Test for leaks
9. Adjust oxygen pressure
10. Adjust acetylene pressure

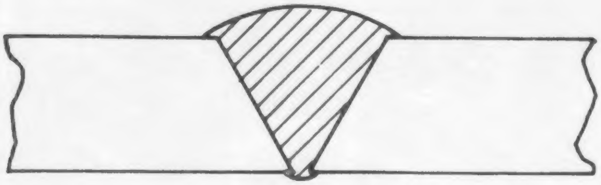
FUSION WELDING AND BRAZING

Fusion welding is a means of joining metals by melting and fusing the edges together.



Fusion weld

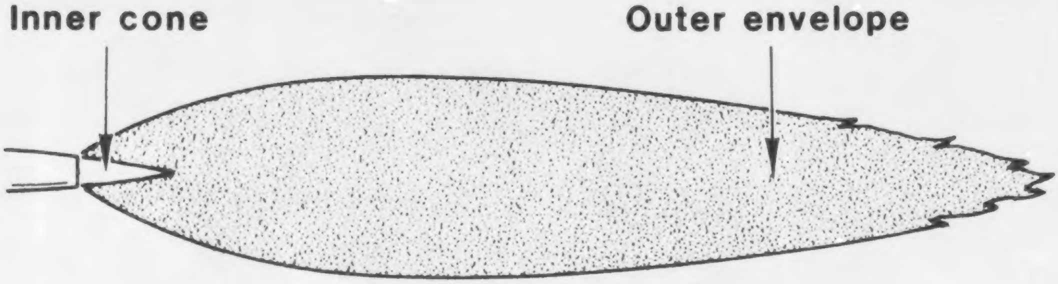
Brazing is a method of welding metals without melting the pieces to be joined.



Braze weld

PROPER PREPARATION FOR BRAZING

1. Clean the weld surfaces
2. Correct spacing
3. Use oxidizing flame


Inner cone
Outer envelope

Oxidizing Flame

4. Select proper rod and flux

STEPS IN BRAZING

1. Clean pieces thoroughly
2. Space pieces properly
3. Adjust blowpipe to slightly oxidizing flame
4. Heat starting point on plate to dull red
5. Test tinning action -- if good, start the bead

PROPER PREPARATION FOR FUSION WELDING

1. Select the proper welding tip and rod

2. Clean the surface

3. Space the pieces

4. Use a neutral flame

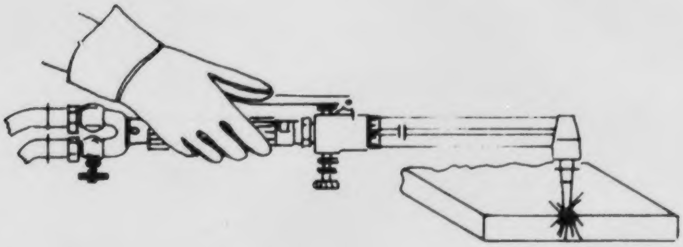
5. Tack-weld

PREPARATION FOR CUTTING

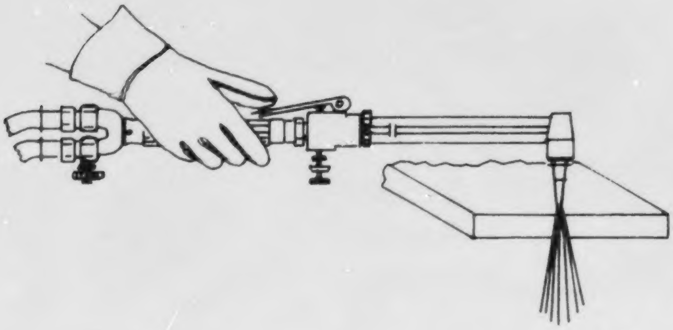
1. Select a suitable place to work
2. Clean the surface to be cut
3. Select the proper nozzle and pressures
4. Light blowpipe and adjust to neutral flame
5. Proper cutting flame adjustment
    a) Open blowpipe oxygen valve as far as you can--leave it wide open
    b) Push down cutting oxygen lever, and adjust flames with needle valve on cutting attachment to a neutral flame

THREE STEPS IN CUTTING

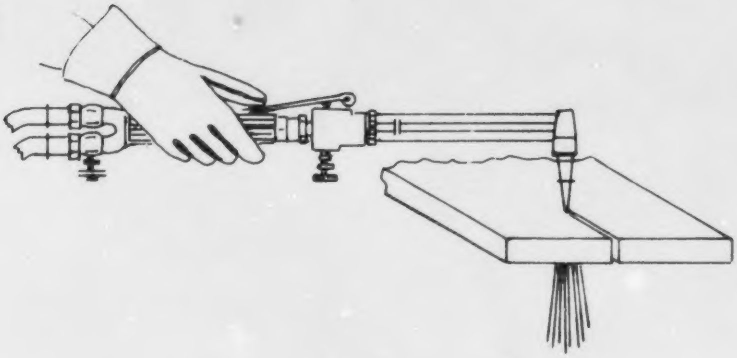
1. Preheating



2. Starting

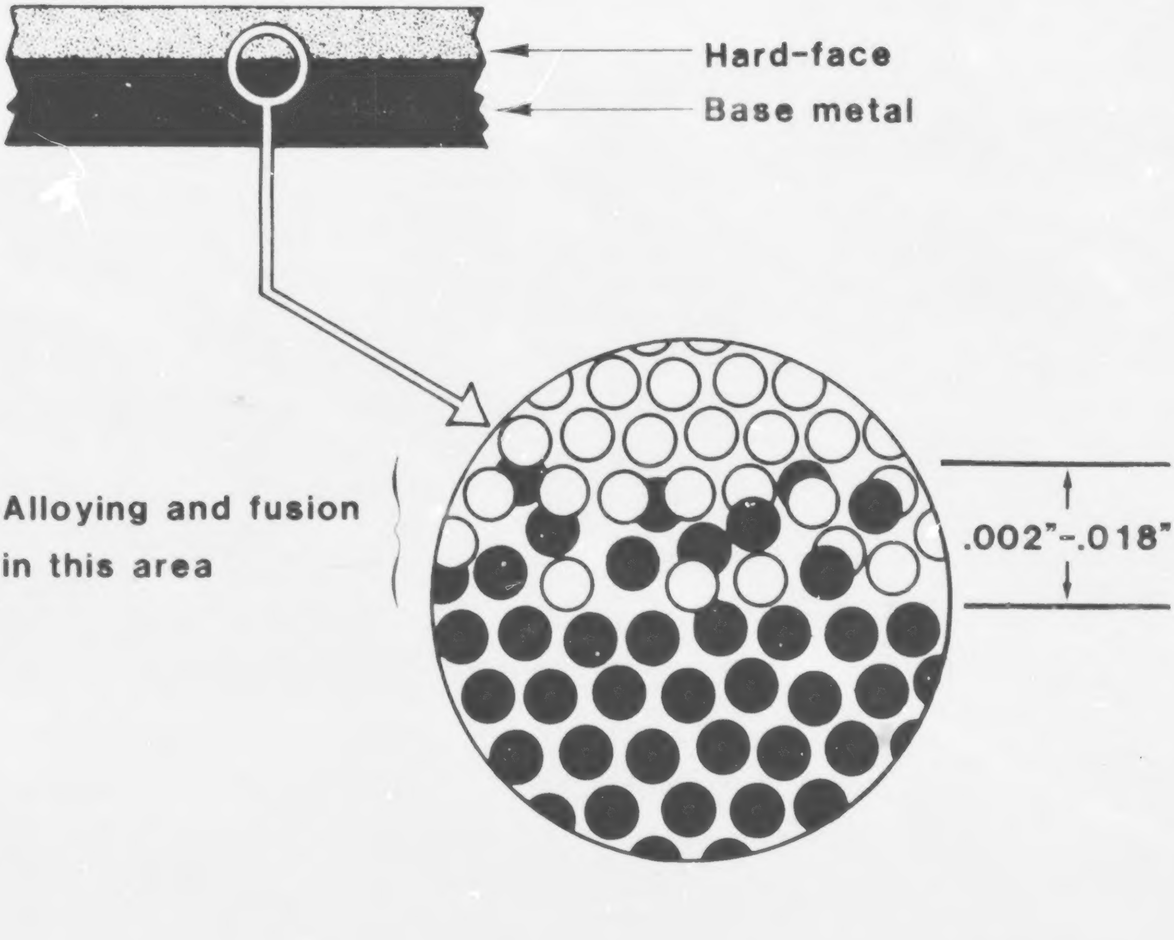


3. Progressing



HOW DOES HARD FACING STICK

Hard facing is the coating of metal surfaces with special alloys to combat wear.


Hard-face
Base metal
Alloying and fusion in this area
.002"-.018"

ADVANTAGES OF HARD FACING

1. Increases life of parts
2. Salvages worn parts
3. Saves money
4. Less power needed
5. Makes better parts
6. Increases efficiency

STEPS IN HARD FACING

1. Clean the surface
2. Adjust blowpipe to carburizing flame
3. Heat starting point to dull red
4. "Sweat" heated area
5. Touch rod to inner cone and "sweating" area
6. Spread puddle with flame
7. Repeat steps 4, 5, 6, until finished
8. Cool part slowly

TRANSPARENCY DISCUSSION GUIDE

DEVELOPING OXY-ACETYLENE WELDING SKILLS

I. Transparency: OXY-ACETYLENE RIG WELDING EQUIPMENT

Use this transparency in conjunction with Worksheet 1 to discuss the different parts of the oxy-acetylene welding outfit.

1. Acetylene cylinder valve wrench - Open and close acetylene cylinder.
2. Acetylene regulator - Regulate acetylene pressure and supply steady flow of low pressure to the torch.
3. Cylinder support - Prevent tanks from falling or tipping.
4. Acetylene cylinder - Store acetylene under high pressure.
5. Fuseable plugs - Melt at 212°F to prevent tank from exploding if subjected to high temperatures.
6. Fuseable plugs.
7. Oxygen safety valve - Ruptures under excessive pressure to prevent tank from exploding.
8. Oxygen cylinder valve - Open and close oxygen tank.
9. Oxygen regulator - Regulate oxygen pressure and supply steady flow of oxygen to torch.
10. Oxygen cylinder - Store oxygen gas under high pressure.
11. Oxygen hose - Green, transport oxygen from regulator to torch.
12. Acetylene hose - Red, transport acetylene gas from regulator to torch.
13. Torch oxygen valve - Control flow of oxygen out of torch.
14. Torch (blowpipe) - Mixing chamber of gasses.
15. Torch acetylene valve - Control flow of acetylene out of torch.
16. Acetylene cylinder cap - Covers acetylene valve when not in use.
17. Oxygen cylinder cap - Covers oxygen cylinder valve when not in use.

II. Transparency - WELDING SAFETY CLOTHING

A. Goggles

1. Discuss the importance of eye protection.
2. Protective lenses should be a shade 3-6 depending on work being performed.

B. Leather Apron

1. Worn to protect clothing from fire.
2. Prevents sparks from entering pockets.
3. Discuss the danger of clothing fires, especially frayed pant legs. Don't carry matches in a shirtpocket!!

C. Leather Gloves

1. Worn to protect hands and wrists from sparks and excessive heat.
2. Discuss the importance of wearing quantlet type gloves to protect arms and shirt cuffs. The longer gloves prevent sparks from flying into the gloves.
3. Remind students that gloves should not be used as "hot pads" to pick up hot metal. This dries out the leather and shortens the life of the gloves.

D. Leather Boots

1. Leather boots are worn to protect feet and ankles from falling sparks and slag.
2. Note that tennis shoes are extremely dangerous and cannot be worn.
3. Note that frayed pant legs are extremely dangerous because they catch fire very easily.

III. Transparency - OTHER SAFETY EQUIPMENT

A. Striker

1. Discuss the use of the striker to light the torch.
2. Emphasize that matches and cigarette lighters should not be used to light the torch because of the hazard of the open flame.
3. Emphasize that each student should light his own torch.

IV. Transparency - TYPES OF WELDING FLAMES

A. Carburizing Flame

1. Discuss lighting the torch, noting that this is the flame that generally occurs when the torch is first lit.

2. Discuss the distinct parts of the flame, demonstrating adding oxygen until the acetylene feather is pulled into the inner cone.
3. Point out that the only use of the carburizing flame is for hard surfacing.

B. Neutral Flame

1. Discuss the aspect of the neutral flame having equal parts of oxygen and acetylene.
2. Point out that this is the flame obtained when the acetylene feather is pulled just into the inner cone by adding oxygen.
3. Emphasize that most fusion welding is done with the neutral flame.

C. Oxidizing Flame

1. Explain and discuss that this flame is simply a neutral flame with slightly more oxygen added.
2. Explain the importance of this flame and that it should be used for all brazing and welding of cast iron.
3. Discuss the soft hissing sound that is obtained when the flame is correct.

V. Transparencies - TYPES OF JOINTS AND FUSION WELDING

1. Use these transparencies to emphasize the various types of joints which can be welded with an acetylene welder.
2. Discuss the proper procedures to use to prepare the metal for each welding joint.
3. Spend extra time discussing the correct procedures to use for the joints the students will be welding.

VI. Transparency - INDUSTRIAL TEMPERATURES

1. Use this transparency to point out the danger of acetylene welding.
2. Point out that with the proper equipment, the oxy-acetylene welder can cut steel three feet thick and also cut under water.

VII. Transparency - TO SET UP AN ACETYENE WELDER

1. Use this transparency as an outline to follow when explaining or demonstrating how to "set-up" a welding outfit.
2. Ask students to perform each step outlined on the transparency.

VIII. Transparencies - FUSION WELDING AND BRAZING, PROPER PREPARATION FOR BRAZING, STEPS IN BRAZING, AND PROPER PREPARATION FOR FUSION WELDING

1. Explain the major differences between fusion welding and brazing.

2. Discuss how to prepare for brazing and outline the steps involved in brazing.
3. Discuss how to properly prepare metal and the welder for fusion welding. Demonstrate how to prepare metal for brazing and fusion welding.

IX. Transparencies - PREPARATION FOR CUTTING, THREE STEPS IN CUTTING

1. Use these transparencies as an outline to follow as you or the students demonstrate how to properly prepare for cutting steel.
2. Discuss and explain how to properly perform the three steps in cutting steel.

X. Transparencies - HOW DOES HARDFACING STICK, ADVANTAGES OF HARDFACING, AND STEPS IN HARDFACING

1. Explain and discuss what hardfacing is and point out its advantages.
2. Have students identify where they could use hardfacing on their own equipment.
3. Discuss how hardfacing sticks to metal and how it is somewhat similar to the way brazing sticks to metal. Point out how this is different from fusion welding.
4. Demonstrate the hardfacing procedures as outlined on the transparency. Have students explain or perform each step in hardfacing process.

TEACHER'S KEY

SAMPLE TE[illegible]TIONS OXY-ACETYLINE WELDING

TRUE OR FALSE (Mark + for true and 0 for false)

0 1. When cutting, tennis shoes are a good substitute when leather boots are not available.

+ 2. The major difference between fusion welding and bronze welding is temperature and alloys.

0 3. When cutting, oxygen pressure should be about 14 psi.

0 4. Class A fires should only be extinguished with Class A fire extinguishers.

0 5. A number 9 shade in the welding goggles would be right for most welding procedures.

0 6. A neutral flame is most often used for brazing.

+ 7. Fusion welding is more difficult to master than brazing.

0 8. Fusion welding is used more often than brazing because brazing does not have adequate strength.

+ 9. In most cases acetylene pressure should be set at 5 psi.

0 10. A quick and safe way to check for leaks is to use a match.

MULTIPLE CHOICE (Make appropriate selection of a,b,c, or d)

C 1. Acetylene can be stored under high pressure only when stabilized with

A. formaldehyde
B. zinc oxide
C. acetone
D. sulphur

B 2. Which of the following is not a part of the welding flame?

A. inner cone
B. outer cone
C. acetylene feather
D. outer envelope

__A__ 3. When brazing, which will occur if the base metal is not hot enough?

A. Rod will roll into a ball or chunk.
B. Rod will move over entire surface area.
C. Rod will drip through the crack in the base metal.
D. None of the above.

__D__ 4. When brazing or fusion welding, edges of the base metal should be tacked with which pair of spacings?

A. 1/4" - 1/2"
B. 1/3" - 1/8"
C. 3/16" - 1/4"
D. 1/8" - 1/16"

__B__ 5. Which is not a step for cutting or piercing a hole?

A. Hold the tip 1/4" away from the surface.
B. When the area is bright red move the tip to within 1/16" of the surface.
C. Depress the oxygen lever and make a small hole.
D. Enlarge the hole by lowering the torch.

__D__ 6. Oxygen hoses are always:

A. Red with left hand threaded fittings.
B. Red with right hand threaded fittings.
C. Green with left hand threaded fittings.
D. Green with right hand threaded fittings.

__A__ 7. Acetylene hoses are always:

A. Red with left hand threaded fittings.
B. Red with right hand threaded fittings.
C. Green with left hand threaded fittings.
D. Green with right hand threaded fittings.

__A__ 8. Which is not a reason to wear safety goggles:

A. Protect the eyes from extreme shop lights.
B. Protect the eyes from flying bits of metal.
C. Protect the eyes and face from extreme heat.
D. Protect the eyes from the brightness of the welding flame.

__A__ 9. A fully charged oxygen tank has a pressure of:

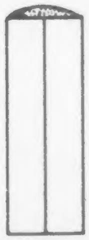
A. 2200 psi
B. 250 psi
C. 1200 psi
D. 220 psi

D 10. A fully charged acetylene tank has a pressure of

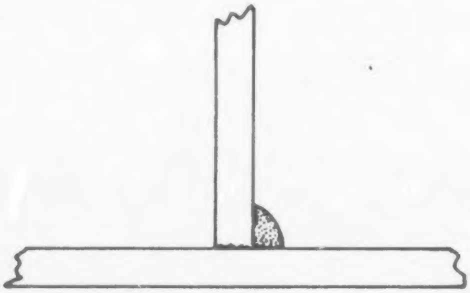
A. 2500 psi
B. 25 psi
C. 300 psi
D. 250 psi

COMPLETION (Fill in the blank with the appropriate information.)

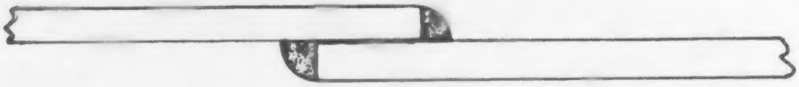
1. Testing for gas leaks should be done with a brush and soapy water.
2. Tips should be cleaned with an appropriate tip cleaner.
3. Before moving tanks, they should always have a cap on them.
4. Before opening a cylinder valve, always turn the regulator handwheel out/left/counter clockwise to prevent pressure from rupturing the diaphragm.
5. When a torch is first lighted the resulting flame is a(an) carburizing flame.
6. Flux is used to clean metal and to float impurities to the top of the weld.
7. When bronze welding cast iron thin layer of rod is laid evenly along the surface. This process is called tinning.
8. Cooling slowly is important when welding cast iron. The weld should be cooled by placing it in sand, or cinders/soot.
9. Uniform penetration should be apparent on the back side of the weld.
10. When making a fillet weld the vertical (flat) piece will melt faster than the horizontal (upright).
11. Identify the following types of weld or joints:



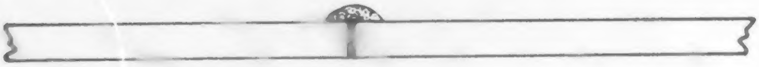
A. **Edge Weld**



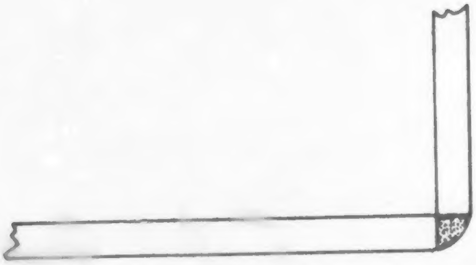
B. **Fillet Weld**



C. **Lap Weld**



D. **Butt Weld**



E. **Outside Corner Weld**

UNIT H: AGRICULTURAL MECHANICS

PROBLEM AREA: SURVEYING IN AGRICULTURE

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is in the spring or fall. The estimated time for teaching this problem area is 10-20 days depending on how much time the teacher wishes to spend on discussion and suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. Students need instruction on methods used to measure and survey the fields used for the student's SOEP.

2. It is important for students to be able to survey crop fields, lay out building sites, profile and differential level in their local community and Illinois.

3. The VAS Surveying Kit will be scheduled to use with this problem area.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts these materials to his/her local situation.

CREDIT SOURCE:

These materials were developed through a funding agreement, R-33-32-D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should they be construed as a policy or opinion of the Illinois State Board of Education or its staff.

The teacher's guide and student job sheets were developed by Steven L. Hendrix, Vo-Ag Instructor, Sullivan High School, Sullivan, Illinois from materials supplied by Jerry Pepple, Department of Vocational and Technical Education, University of Illinois. Dr. Len Harzman, Western Illinois University reviewed the text of this problem area and made valuable suggestions for improving the materials.

Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Agricultural mechanics

II. Problem area: Surveying in agriculture

III. Objectives: At the close of this problem area the students will:

1. Know the equipment needed for farm surveying.
2. Be able to properly care for surveying equipment.
3. Be able to properly use surveying equipment.
4. Be able to properly keep field notes.
5. Be able to:
    - a. Determine distances
    - b. Determine areas
    - c. Measure angles
    - d. Measure slope
    - e. Differential level
    - f. Profile level
    - g. Stake out a building site
    - h. Erect batter boards
    - i. Stake out a fence line

IV. Suggested interest approaches:

1. Lead a discussion by asking the student if they have ever helped survey, tape or stake out a building site.
2. Have a resource person as a guest speaker to discuss the importance of surveying in agriculture (Soil Conservation Service, etc.).
3. Discuss the careers that require surveying skills.
4. Discuss the issues involved in doing surveying yourself rather than hiring others to do it.
5. Discuss the agricultural applications of surveying skills.
6. Discuss the types of surveying generally used in agriculture.
7. List agencies who use surveying for agricultural purposes.

V. Anticipated problems and concerns of students:

1. When could I use surveying skills in agriculture?
2. What equipment is needed for surveying?
3. What agricultural jobs need people with knowledge and skills in surveying?
4. What are some common types of surveying?
5. What types of records and notes are kept when surveying?
6. How do I complete a field notebook?
7. What symbols are used in agricultural surveying?
8. How can I determine distance and areas?
9. Do I have to be a math major to do surveying?
10. When do I use a hand level?
11. How do I use a hand level?
12. How do I use a tripod level?
13. How do I read a target rod?
14. What is differential leveling?
15. How do I do differential leveling?
16. What is profile leveling?
17. How do I do profile leveling?
18. How do I stake out a building foundation when using surveying equipment?
19. How do I use surveying equipment to stake out a fence line?
20. How do I properly handle and care for surveying equipment?

VI. Suggested learning activities and experiences:

1. Prepare and conduct an interest approach on agricultural surveying. Then have students identify some problems and concerns relating to surveying. Distribute and review Information Sheet, "Approved Practices for Surveying."

2. Have students identify situations where they needed surveying skills to complete a home project or SOE project. After students have developed an interest in agricultural surveying explain the skills they will develop and the types of surveying they will be doing in this problem area. Show and discuss transparencies on the level.

3. Distribute VAS Unit 3010a, "Agricultural Surveying," and Student Worksheet #1, "Determining Distances." Conduct supervised study to answer selected questions. Discuss and explain the taping and measuring methods and skills.

4. Have students read Part 3 in VAS Unit 3010a, then show and discuss VAS Slidefilm 436a, "Surveying Using the Steel Tape" Distribute the following worksheets for students to complete and discuss:
   a. Worksheet 2, "Measuring Angles With The Steel Tape".
   b. Worksheet 3, "Determining Field Areas".

5. Distribute and explain Job Sheet 1, "Determining Distances", and Job Sheet 2, "Measuring Angles". Make student assignments and use the VAS Surveying Kit during these exercise and Information Sheet, "Table of Sines".

6. Show VAS Filmstrip 438-A, "Using the Level in Farm Surveying". Have students read pages 12-14 in Part 5 of VAS Unit 3010a. Distribute Worksheet 4 and let students answer the questions and then practice setting up the tripod level and reading the target rod. Use tranparencies on the target rod and hand motions in surveying.

7. Distribute Worksheet #5, "Differential Leveling", and have students read pages 14-16 in Part 5 of VAS Unit 3010a. Show VAS Slidefilm 437a, "Field Notes for Surveying", frames 1-29. If necessary, conduct supervised study to assist students in properly completing the exercises in Worksheet 5. Refer to Job Sheet, "Setting Up and Adjusting the Farm Level".

8. Distribute the necessary surveying equipment to students and have them complete Job Sheet 3, "Differential Leveling" for field experience.

9. Distribute Worksheet 6, "Profile Leveling", and assign students to read pages 16-18 in Part 5 of VAS Unit 3010a. Show and discuss VAS Slideflim 437a, "Field Notes for Surveying", frames 30-40. Conduct a supervised study or use small groups to assist students in completing and understanding the techniques of profile surveying.

10. Distribute the necessary surveying equipment to assigned student groups and distribute Job Sheet 4, "Profile Leveling". Have students complete the exercise to obtain "hands-on" experience in doing profile surveys.

11. Assign Part 4 in VAS Unit 3010a, "Using the Hand Sighting Level", and show and discuss frames 7-15 of VAS Filmstrip 438a, "The Level in Farm Surveying". Distribute Worksheet 7, "Using the Hand Level", and have students complete the assignment for evaluation and discussion.

12. Distribute Job Sheet 5, "Using the Hand Level", and have students perform the assigned exercise to obtain practical field experience in using a hand level.

13. Assign students to read pages 18-20 in VAS Unit 3010a. Distribute Worksheet 8, "Staking out a Building Foundation", and show and discuss VAS Filmstrip 439a, "Staking Out a Building Site". Have students answer the questions through supervised study then use class discussion to determine the final answers to the worksheet.

14. To obtain better student understanding of the principles and procedures involved in staking out a building assign Job Sheet 6 "Staking Out a Building". Evaluate student performance in accurately completing the demonstration.

15. An alternate method of teaching this problem area is to complete much of the classroom instruction before the VAS Surveying Kit arrives. Then, when you receive the surveying kit, divide the class into six small groups and assign each small group a different exercise to begin with. Then have them rotate after three days on each assignment until each group completes all six exercises.

VII. Application procedures:

1. The main purpose of this problem area is to learn to use surveying equipment in a proper manner.

2. The students should use their knowledge and understanding learned in field exercises on the home farm or in their place of employment.

VIII. Evaluation:

1. Prepare and administer a pencil and paper test covering identification and proper use of surveying equipment.

2. Collect and grade worksheets.

3. Grade field exercises.

IX. References and aids:

1. Vocational Agriculture Service, University of Illinois, Urbana, IL

    a. VAS Unit 3010a "Agricultural Surveying"

    b. VAS Slidefilms: 436a "Surveying Using Steel Tape"
    437a "Field Notes for Surveying"
    438a "The Level in Farm Surveying"
    439a "Staking Out a Building Site"
    c. Field Notes for Surveying
    d. Survey Kit

2. Selected transparencies

3. Student worksheets

4. Student job sheets

5. Student information sheets

6. Sample test questions

INFORMATION SHEET

APPROVED PRACTICES FOR SURVEYING*

1. In order to plan and establish mechanical practices it is necessary to know the differences in elevation. This requires a knowledge of some of the engineering instruments.

2. Four kinds of levels are commonly used in farm conservation work.

   a. The engineer's wye level.
   b. The dumpy level.
   c. The Locke hand level.
   d. The abney level.

3. The Locke hand level is used for rough measurements of differences in elevation. It is satisfactory for laying out contour lines, strips, and for sizing up an area for a pond.

4. The abney level is similar to the Locke hand level except that it is equipped with a graduated arc for reading per cent of slope.

5. Survey instruments are precise, delicate pieces of equipment and are expensive. Therefore, they should be handled with utmost care.

6. In mounting the wye and the dumpy level on the tripods, be sure that you follow the instructions of the manufacturer. Practice will enable you to get the feel so that you will not tighten the nuts too much.

7. Carry the instrument on the shoulder, mounted on the tripod. Don't allow the instrument to fall.

8. From the very beginning, cultivate the habit of delicate manipulation of the instrument.

9. Store engineering instruments in a dry place. Keep them clean.

10. Learn your "pace factor" by practicing pacing a measured distance, for example 500 feet. The pace factor is the distance in feet divided by the number of paces.

11. Chaining is the most common method of measuring horizontal distances with required accuracy.

12. Survey lines are measured in stations. The distance between full stations is 100 feet.

13. Dumpy and wye levels can be used to:

    a. Measure slope in per cent by reading the difference in elevation between two points 100 feet apart.

b. Stake out contour lines by reading from where the level is set up along a level line.

c. Stake out terraces by reading from the level along a line that is graded by adjusting the reading at each stake.

d. Run profiles of gullies and other areas by plotting on graph paper the elevations at various points.

*From Foster, Albert B. Approved Practices in Soil Conservation, The Interstate Printers and Publishers, Danville, Illinois.

INFORMATION SHEET

TABLE OF SINES

ANGLE DEGREES	SINE OF ANGLE	ANGLE DEGREES	SINE OF ANGLE	ANGLE DEGREES	SINE OF ANGLE
1	0.017	31	0.515	61	0.875
2	0.035	32	0.453	62	0.883
3	0.052	33	0.545	63	0.891
4	0.070	34	0.559	64	0.899
5	0.087	35	0.574	65	0.906
6	0.105	36	0.588	66	0.914
7	0.122	37	0.602	67	0.921
8	0.139	38	0.616	68	0.927
9	0.156	39	0.629	69	0.934
10	0.174	40	0.643	70	0.940
11	0.191	41	0.656	71	0.946
12	0.208	42	0.669	72	0.951
13	0.225	43	0.682	73	0.956
14	0.242	44	0.695	74	0.961
15	0.259	45	0.707	75	0.966
16	0.276	46	0.719	76	0.970
17	0.292	47	0.731	77	0.974
18	0.309	48	0.743	78	0.978
19	0.326	49	0.755	79	0.982
20	0.342	50	0.766	80	0.985
21	0.358	51	0.777	81	0.988
22	0.375	52	0.788	82	0.990
23	0.391	53	0.799	83	0.993
24	0.407	54	0.809	84	0.995
25	0.423	55	0.819	85	0.996
26	0.438	56	0.829	85	0.998
27	0.454	57	0.839	86	0.999
28	0.469	58	0.848	87	0.999
29	0.485	59	0.857	88	1.000
30	0.500	60	0.866	90	1.000

The Sine of an acute angle in a right triangle is the length of the side opposite the angle divided by the length of the hypotenuse. This trigonometric table is to be used for determining angles and can be used for calculating the area of a triangle.

STUDENT WORKSHEET #1

DETERMINING DISTANCE

1. Describe the process of determining distances by:

   a. Odometry

   b. Pacing

   c. Tachymetry

   d. Electronic Devices

   e. Steel Tape

2. What are the possible causes of errors in measurement?

3. What is the length of a Gunter's Chain?

4. How many persons are needed for a taping crew? What are the jobs of each?

5. A surveying party is about to complete the measurement of a horizontal distance. The head tapeman has the marking pin ring with six pins on it; the rear tapeman has 3 pins in his hand. A pin remains in the ground where the head tapeman placed it upon hearing the signal "right here" just before he proceeded to the terminal point. The final reading shows that the two pins are 37.24 feet apart. Assuming that the distance is less than 1000 feet, what is the total distance which the party has just measured?

WORKSHEET #2

MEASURING ANGLES WITH THE STEEL TAPE

1. When are precise perpendicular or right angles needed?

2. Explain the 3-4-5 Method for finding a right angle.

3. Explain the chord method.

4. How can an existing angle be measured? Explain.

WORKSHEET #3

DETERMINING FIELD AREAS

1. What is the formula for determining area of the following:

    A. Rectangle

    B. Triangle

        I. Common method

        II. Alternate method

    C. Trapezoid

    D. Four sides - None parallel

    E. Curved boundary/one side straight

    F. All sides curved

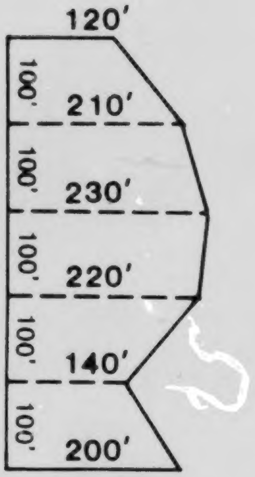
    G. Long narrow curved area

2. Determine the area of the fields on the following page in square feet and in acres.

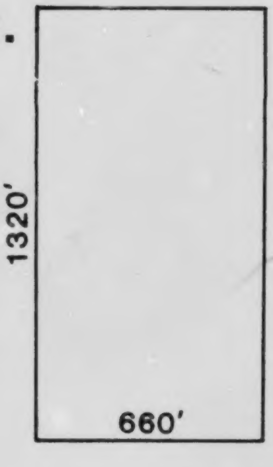
Find the number of acres in each of the following fields.

Show ALL of your work!

1.


120′
100′
210′
100′
230′
100′
220′
100′
140′
100′
200′

2.



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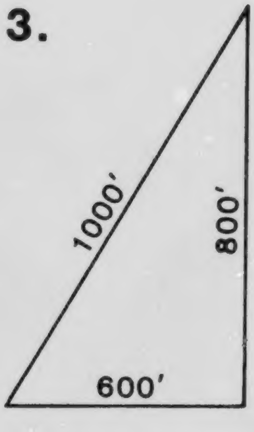
1000′
800′
600′

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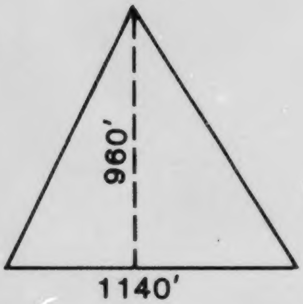

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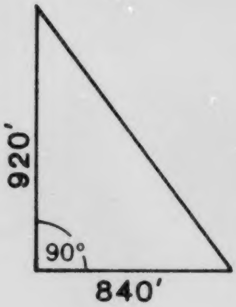

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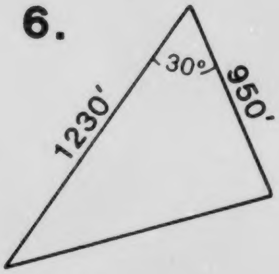

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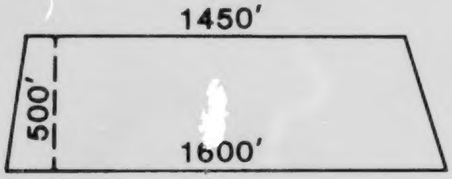
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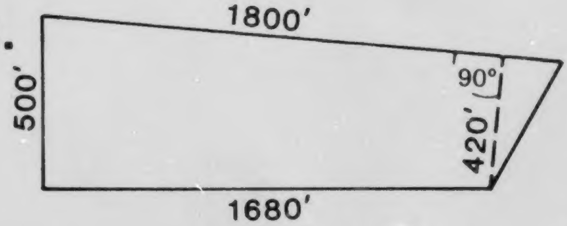
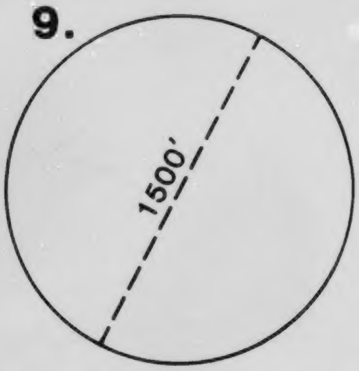
500′
1600′

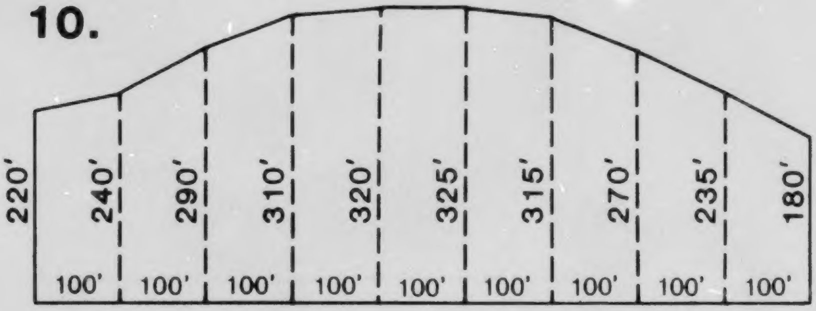
8.


1800′
90°
500′
420′
1680′

9.



10.


220′
240′
290′
310′
320′
325′
315′
270′
235′
180′
100′
100′
100′
100′
100′
100′
100′
100′
100′

II-H-3-16

WORKSHEET # 4

USING THE TRIPOD LEVEL

1. How is the instrument most safely transported?

2. What is done with the lens cap? Tripod cap?

3. Where is the instrument box placed?

4. What care should be taken before moving the tripod?

5. Why should an instrument never be leaned against a fence or building?

6. What should be used to support the tripod legs if set up on a floor?

7. How securely should the leveling screws be drawn?

8. What is done to the leveling screws before returning to the box?

9. How should the instrument be carried out of doors?

10. How should the instrument be carried inside or through shrubs and bushes?

11. What is the correct way to cross a fence with an instrument?

12. When is the sunshade used?

13. How are the lenses cleaned?

WORKSHEET #5

DIFFERENTIAL LEVELING

1. What is differential leveling?

2. Explain the process of differential leveling.

3. What is allowable error?

4. How is allowable error calculated?

5. Record the following data in standard form as it would appear in a field notebook.

   These statements represent brief descriptions of the activities performed by the surveying party.

   a. Prepare to do differential leveling on the John Farmer farm located in the E 1/2 of the NW 1/4, Section 24, T6N, R3E, 3rd Prin. Meridian.

   b. Set up instrument and leveled it.

   c. Took sight on bench mark #1. . .5.24'

   d. Took sight on turning point #1. . .6.35'

   e. Moved instrument and leveled it.

   f. Took sight on T.P. 1. . .4.83'

   g. Took sight on T.P. 2. . .5.03'

   h. Moved instrument

   i. Took sight on T.P. 2. . .1.31'

   j. Took sight on T.P. 3. . .3.52'

   k. Moved instrument

   l. Took sight on T.P. 3. . .5.07'

   m. Took sight on T.P. 4. . .4.73'

   n. Moved instrument

   o. Sighted on T.P. 4. . .4.61'

p. Sighted on point A. . .3.57'

q. Sighted on T.P. 5. . . 2.32'

r. Moved instrument

s. Sighted on T.P. 5. . .3.11'

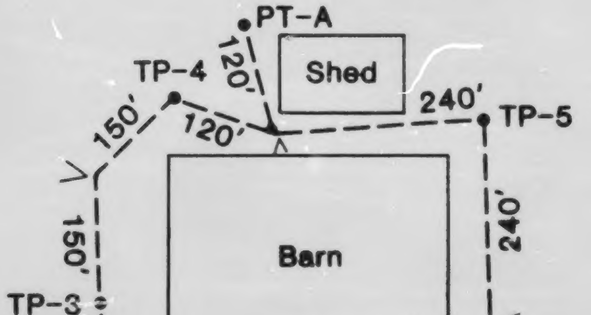
t. Sighted on T.P. 6. . .2.46'

u. Moved Instrument

v. Sighted on T.P. 6. . .5.91'

w. Sighted on B.M. 1. . .6.65'

The following is a sketch of the location of the bench marks and turning points. This information is to be appropriately recorded and also used to determine if the errror is a reasonable amount.


PT-A
Shed
TP-4
120'
120'
240'
TP-5
150'
150'
Barn
240'
TP-3
150'
240'
150'
TP-6
TP-2
150'
240'
150'
TP-1
240'
150'
BM-1
150'

6. From the following descriptive notes, make appropriate entries in standard form. (Vocational Agriculture Service field notes for surveying). Label columns correctly and make all calculations necessary to complete a differential leveling problem.

a. Set up the instrument and leveled it.

b. Took a sight on bench mark 1 . . .4.36'

c. Took a sight on turning 1. . .5.32'

d. Moved instrument

e. Sighted on T.P. 1. . .5.81'

f. Sighted on T.P. 2. . .3.41'

g. Moved instrument

h. Sighted on T.P. 2. . .7.33'

i. Sighted on point A. . .4.25'

j. Sighted on T.P. 3. . .6.23'

k. Moved instrument

l. Sighted on T.P. 3. . .4.20'

m. Sighted on B.M. #1. . .6.73'

WORKSHEET #6

PROFILE LEVELING

1. What is meant by profile leveling?

2. Where is profile leveling used?

3. Explain the process of profile leveling.

4. Work out the following profile survey and figure the grade elevation, cut and width of a surface drain to drain point 4+00 into point 0+00 using a 5:1 side slope on the ditch.

Station	Back Sight	Height Instrument	Fore Sight	Elevation	Grade Elevation	Cut	Width
BM - 1	2.60			50.00			
0+00		6.60					
0+50		6.40					
1+00		6.10					
1+50		5.40					
2+00		5.20					
TP - 1	8.05	9.65					
2+50		3.40					
3+00		2.80					
3+50		3.10					
4+00		3.40					
TP - 2	7.94	5.86					
BM - 1		3.08					

5. Work out the following profile survey and figure the grade evaluation cut or fill and width of a surface drain to drain from 3+00 to 0+00 using a 5:1 side slope on the ditch.

Station	Back Sight	Height of Instrument	Fore Sight	Elevation	Grade Elevation	Cut/ Fill	Width
BM - 1	5.62			100.00			
0+00			3.12				
0+50			3.80				
1+00			4.46				
1+50			5.06				
TP - 1	5.32		4.62				
2+00			2.93				
2+50			1.68				
3+00			0.82				
TP - 2	4.16		6.32				
BM - 1			4.16				

6. Work out the following profile survey for a surface drain using a 5:1 side slope on the ditch.

Station	Back Sight	Height of Instrument	Fore Sight	Elevation	Grade Elevation	Cut/ Fill	Width
BM - 1	4.50			100.00			
0+00			8.02				
0+50			7.85				
1+00			6.42				
TP - 1	7.28		7.77				
1+50			5.03				
2+00			4.72				
2+50			4.31				
3+00			4.07				
TP - 2	5.37		3.91				
BM - 1			5.42				

WORKSHEET #7

USING THE HAND LEVEL

1. Explain how a contour line can be found with the hand level.

2. Explain how slopes can be measured using the hand level.

3. If your eye level is 5 feet, determine the percent slopes on the following readings: The distance read is 25 feet.

    A - 5'6"

    B - 4'8"

    C - 3'

    D - 4'1"

    E - 5'0"

    F - 4'10"

    G - 2'1"

    H - 1'3"

    I - 2'6"

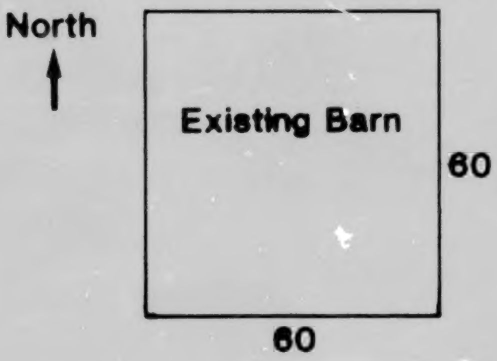
    J - 1'4"

WORKSHEET #8

STAKING OUT A BUILDING FOUNDATION

1. How can new building locations be found with a surveying instrument?

2. Explain how, in a step-by-step method, you would lay out a building site for a proposed implement shed to be built if the owner wants it 20 feet south and 20 feet east of the barn. The building will be 60 X 20 in size with an east entrance.



3. Explain, step-by-step, how you would lay out a fence at a 90° angle from an existing fence.

4. What is the method of assuring that your building layout is "square?"

5. Where are new farm buildings usually located?

6. How is the level located over an exact point?

7. Name as many items as you can that are needed to stake out a building.

8. How can the convertible level be used to extend a line?

9. How can the convertible level be used to mark off a 90° angle?

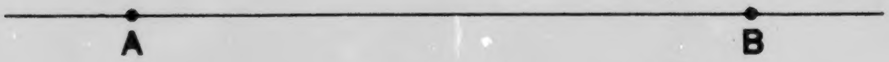
10. How can a building site be checked to be sure it is rectangular?

11. What is the purpose of batter boards?

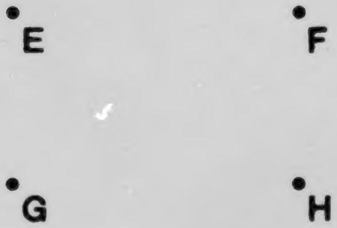
12. Describe how the level is used to set the batter boards at the desired height.

13. How are batter boards marked to preserve the correct location of the strings?

14. Describe procedure for locating the four corners of a building, 40' x 90', with the long side being located from point A along the line toward B.



15. Explain and show by diagram how batter boards and string would be used to stake out a building foundation with corners EFGH as shown below.



JOB SHEET

SETTING UP AND ADJUSTING THE FARM LEVEL

I. Tools and equipment

   A. Instrument

   B. Tripod

II. Procedure

   A. Grasp the two legs of the tripod that are nearest you and set the leg shoes in the ground about three feet apart.

   B. Swing third leg out to form a triangle (NOTE: If the ground is not level, you may have to change position of tripod in order to keep head plate level. Always place two legs on downhill or unlevel).

   C. Tighten leg thumb nuts

   D. Check head plate to see if it is level

   E. Remove instrument from carrying case by lifting the level bar
   (CAUTION: Keep a firm grip on instrument until it is securely in position on tripod).

   G. Remove dust cap from front lens
   (NOTE: The dust cap should be kept in place in order to protect the lens from dust or scratches).

   H. Attach sun shade to the instrument

   I. Align telescope barrel directly over one pair of leveling screws
   (NOTE: The leveling screws will be used to level the instrument).

   J. Rotate screws under the leveling head to bring bubble to the center of the leveling tube
   (NOTE: Move your thumbs in opposite directions).

   K. Check bubble to see if it is centered

   L. Turn instrument clockwise through 90 degrees to align with other pair of leveling screws

   M. Bring bubble to center of marks by rotating leveling screws

   N. Turn instrument clockwise through 90 degrees to bring it parallel with first pair of leveling screws

O. Center bubble again

P. Turn instrument clockwise through 90 degress to bring it parallel with second pair of leveling screws

Q. Center bubble again (NOTE: Bubble should stay in center regardless of what direction telescope is pointing. If bubble does not, instrument is out of level and should be adjusted by competent personnel).

R. Focus cross hairs so that they appear sharp and clear (NOTE: Focusing is accomplished by looking through the eye piece ring until the cross hairs become sharp or "clear").

S. Rotate the focusing screw to bring target into sharp focus (NOTE: When cross hairs and targets are in sharp focus, you should be able to read a rod accurately. Always tie level shots back to starting bench mark to check for error in rod shots or in field notes).

(CAUTION: After instrument is level, keep hands off tripod. Use the instrument only. If instrument creeps off level or is bumped, stop, reset tripod, relevel instrument, and start again from the last known good bench mark).

JOB SHEET #1

DETERMINING DISTANCES

Objectives:

1. To develop the ability to tape or pace distances accurately.
2. To become familiar with both methods of determining distance.

Materials:

1. 100 foot tape
2. 11 marking pins
3. Field notebook and pencil
4. Map or area to be measured

Procedures:

A. Teacher

   1. Set up area to be measured by placing stakes, flags or other markers at intervals about the area to be used. Label this 1, 2, 3 etc.
   2. Distribute job sheet and instruct the students as to which measurements are to be made.
   3. Repeat this activity until students master the skills involved.

B. Student

   1. Work with your assigned crew. Crew members should rotate job assignments so that each person has the experience of acting as head tapeman, rear tapeman, and recorder.
   2. Measure the distance between the indicated stakes (center to center) and record the information to the nearest .01 foot, in the field notebook. Tape each distance twice (forward and backward) and record in the field notebook. It should be remembered that in measuring distance on a slope of more than 2%, the tape should be held horizontal or a slope correction factor should be used. Refer to VAS Unit 3010a, page 6 for slope correction table.

Distances Measured

	Pacing	Taping
1 - 2		
1 - 3		
1 - 4		
1 - 5		
1 - 6		
2 - 3		
2 - 4		
2 - 5		
2 - 6		
3 - 4		
3 - 5		
3 - 6		
4 - 5		
4 - 6		
5 - 6		

(Any or all distances may be chosen to be measured)

Questions:

1. What are some problems that may cause inaccurate measurements?
2. What can be done to assure accuracy in your measurements?

Observation:

Become familiar with the equipment and procedures involved in the taping operation.

Conclusions:

Discuss how the students' ability to measure may be used to improve their SOEP.

JOB SHEET #2

MEASURING ANGLES

Objectives:

To become familiar with the practice of measuring and determining angles using the steel tape

Equipment and Supplies:

1. Steel tape
2. Marking pins
3. Range poles or stakes
4. Map of area
5. Table of sines
6. Field notebook and pencil

Procedures:

1. Each crew will demonstrate an ability to lay out a right angle using:
   A. 3-4-5 Method
   B. Chord Method
2. Each crew will demonstrate the ability to measure an angle using the sine method.
3. The sides of the triangle will be determined by sighting on 3 stakes which the group will be assigned.
4. Starting at the apex of the angle to be measured, measure 100 feet along each side of the angle setting a pin at the 100 foot mark. A range pole may be useful to align the marking pin on the side of the angle.
5. Measure the distance between the two marking pins which were placed in step two.
6. Divide the distance by two.
7. Divide the quotient of part 6 by 100.
8. Refer to the sine table to find the number in 1/2 the angle being measured.

9. Double the value in six to find the size of the total angle being measured.

NOTE: Any distance can be used in step 4. However, the division becomes more difficult than simply moving the decimal.

10. Your group or crew will measure the three angles of the triangle formed by the stakes. Your instructor will give your specific assignment.

ANGLE DESCRIPTION	DISTANCING BETWEEN SIDES AT 100' MARKS	1/2 THE DISTANCE	SINE OF ANGLE	1/2 THE ANGLE	FULL ANGLE

Questions:

1. What are the areas of concern to watch for in preventing errors in measurement?

2. Why are these skills important to today's agriculture?

Observation:

Become familiar with the procedures involved with the determining of angles using the steel tape.

Application:

Discuss how this skill can be used in each student's SOEP.

JOB SHEET #3

DIFFERENTIAL LEVELING

Objectives:

1. To understand the process of differential leveling.
2. To develop the skills used in differential leveling.

Materials:

1. Tripod and level
2. Target rod
3. Map of area
4. Field notebook and pencil

Procedures:

1. The teacher will place 6 stakes at intervals around the survey field.
2. Use the top of stake #1 as BM 1 (100' elevation).
3. Find the elevation of the top of the stakes to which your group is assigned.
4. Use a turning point between the two stakes farthest apart, otherwise one instrument set-up between each pair of stakes will be sufficient.
5. Close the traverse of returning to stake 1 to check the accuracy of your work.
6. Record all notes in the standard form in a field notebook as the work progresses. This should include an appropriate sketch, weather conditions, date, survey party members, etc. on the right page as well as the title and record the data on the left page. (Rotate jobs to obtain practice).

Questions:

1. How is differential leveling used by the farmer?
2. What other industries or persons might use these skills?
3. What are the sources of error in a differential leveling survey?

4. What is allowable error?

5. How is allowable error calculated?

Observations:

Correctly measure the difference in elevation between two points. Become familiar with the skills and techniques used to do a differential leveling survey.

Application:

Identify and discuss the areas where this skill could be used to help improve the student's S.O.E.P.

JOB SHEET #4

PROFILE LEVELING

Objectives:

1. To become familiar with the techniques involved in profile leveling.
2. To develop the ability to accurately run a profile survey.

Materials:

100 foot tape

Marking pins

Tripod level

Target rod

Range poles

Procedures:

1. Refer to pages 16 and 17 of VAS Unit 3010a for instructions for profile leveling.
2. The teacher will place stakes along the area to be surveyed.
3. Students will begin at stake #1 and designate this as station O. Then, they should proceed along that line taking readings at 25 foot intervals. When the survey team has reached the end point designated by the instructor they should then sight back to station O. (Rotate jobs to gain experience).
4. These data should be properly entered in the field notebook.
5. Survey for surface ditch
6. Record in proper form, showing cut for each station
7. Upper end of ditch is at 0+00. Outlet at 4+50.

Questions:

1. What uses can this skill be put to?
2. How can errors in the survey be avoided?

Observation:

Become proficient at the skills involved in profile leveling.

Application:

Discuss how this unit could be used to improve the student's S.O.E.P.

JOB SHEET #5

USING THE HAND LEVEL

Objectives:

1. To become proficient with the use of the hand level.
2. To be able to determine slope with the hand level.
3. To be able to lay out contours with hand level.

Materials:

Hand level
Target rod or range pole

Procedures:

SLOPES

1. The instructor must locate the slopes to be measured and place stakes at 25 foot intervals.
2. The students must determine eye level.
3. The student may now read the slope, subtracting his or her eye level from the reading.
4. Multiply the remainder by 4. This represents the inches per 100 feet of slope 12 inches = 1%
5. Remember it is always best to take your readings from the downhill position.

CONTOURS

1. Select an area to be contoured.
2. Select a starting point. The rodman then proceeds at 25-50 foot intervals to locate that same elevation in the slope.
3. When the proper location is found drive a stake at that point and move on.
4. Continue this process until the contour is complete.

Questions:

1. How can these skills be used on a farm or agriculture business?
2. What things must be done to assure accuracy?
3. What can you do to improve your skills?

Observations:

Become familiar with the equipment and procedures used in determining slope and laying out contours.

Learn how to lay out a contour and determine percent slope correctly.

Application:

Discuss how use of the hand level can be used on the student's S.O.E.P.

JOB SHEET #6

STAKING OUT A BUILDING

Objectives:

To become familiar with the procedures involved in laying out building sites.

To develop the ability to properly layout buiding sites.

To become familiar with the procedures used to lay out a fence line.

Materials:

100 foot tape
Tripod and level
Target rod
Marking pins
4 - 2 X 2 stakes
1 - 1 X 2 stakes
8 - 1 X 4 boards
Nails
Hammer
Carpenters level
String
Sledge hammer
Saw

Procedures:

1. The instructor must select an adequate building site.
2. The student should refer to pages 18 - 21 in VAS Unit 3010a for instructions for staking out a building and a fence line.
3. Each teacher should devise a building to fit the site.
4. The top of the batter boards should be 1 foot higher than the elevation of the stake when using stake #1 as the bench mark (elevation = 100).
5. 1" X 2" stakes will be used for batter board stakes to avoid making excessively large holes in ground. In actual practice a 2" X 4" stake would be preferred.
6. The batter boards should be approximately 2' outside of the foundation line.

Questions:

1. How is the plumb-bob used in locating a building site?
2. What is the function of batter boards?
3. How are batter boards leveled?
4. What is the function of the string on the batter boards?

Observations:

Become familiar with skills and techniques involved in building location.

Develop the ability to lay out building site and erect batter boards.

Correctly lay out building site and erect batter boards.

Application:

Discuss how these abilities can be used on the student's SOEP's

TEACHER'S KEY

STUDENT WORKSHEET #1

DETERMINING DISTANCE

1. Describe the process of determining distances by:

   A. Odometry
   Found by counting the # of Revolutions of a wheel of known circumference.

   B. Pacing
   Counting the number of steps in a distance

   C. Tachymetry
   An Engineering method.

   D. Electronic Devices
   Uses an induced signal and measures time differences

   E. Steel Tape
   Uses 100 foot tape

2. What are the possible causes of errors in measurement?

   1. Incorrect tension on the tape
   2. Tape is not aligned
   3. Pins are not correctly placed
   4. Mistake in counting pins
   5. Did not use plumb bob on slopes
   6. Read wrong numbers
   7. Recorded wrong numbers

3. What is the length of a Gunter's Chain?
   66 feet

4. How many persons are needed for a taping crew? What are the jobs of each?

   Head Tapeman:
   - a. Carries ring and pins
   - b. Places one pin at start
   - c. Carries zero end of tape

   Rear Tapeman:
   - a. Keeps Head Tapeman on line to be measured
   - b. Carries 100 foot end of tape
   - c. Keeps pins to account for distance measured

   Recorder:
   - a. Keeps notebook on distance measured
   - b. Records conditions and sketch of area

5. A surveying party is about to complete the measurement of a horizontal distance. The head tapeman has the marking pin ring with six pins on it; the rear tapeman has 3 pins in his hand. A pin remains in the ground where the head tapeman placed it upon hearing the signal "right here" just before he proceeded to the terminal point. The final reading shows that the two pins are 37.24 feet apart. Assuming that the distance is less than 1000 feet, what is the total distance which the party has just measured? 337.24 feet

TEACHER'S KEY

WORKSHEET #2

MEASURING ANGLES WITH THE STEEL TAPE

1. When are precise perpendicular or right angles needed?
   Property Lines, Fence Lines

2. Explain the 3-4-5 Method for finding a right angle.
   VAS Unit 3010a, Page 7

3. Explain the chord method.
   VAS Unit 3010a, Page 7

4. How can an existing angle be measured? Explain.
   VAS Unit 3010a, Page 7

TEACHER'S KEY

WORKSHEET #3

DETERMINING FIELD AREAS

1. What is the formula for determining area of:

   A. Rectangle $A = B \times H$

   B. Triangle

      I. Common method $A = \frac{B \times H}{2}$

      II. Alternate method $A = \frac{\text{Length AB} \times \text{Length AC} \times \text{Sine A}}{2}$

   C. Trapezoid $S = \frac{(S + S) \times H}{2}$

   D. Four sides - none parallel. Divide into two triangles

   E. Curved boundary/one side straight. See VAS Unit 3010a, page 9.

   F. All sides curved. See VAS Unit 3010a, page 10.

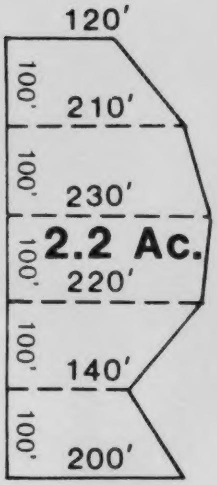
   G. Long narrow curved area. See VAS Unit 3010a, page 10.

2. Determine the area of the fields on the following page in square feet and in acres.

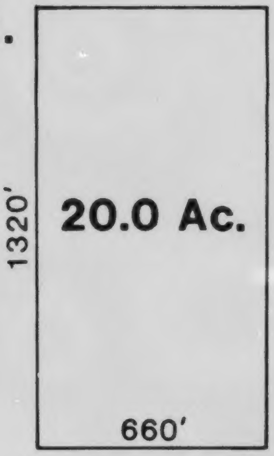
Find the number of acres in each of the following fields.

Show ALL of your work!

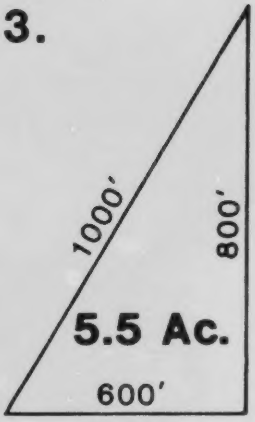
1.


120'
100'
210'
100'
230'
100'
2.2 Ac.
220'
100'
140'
100'
200'

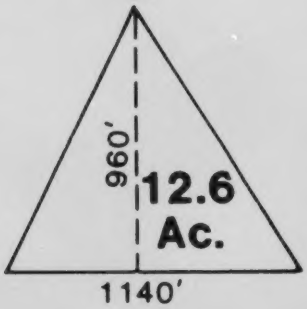
2.


1320'
20.0 Ac.
660'

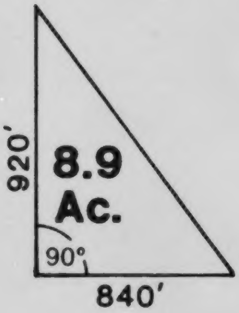
3.


1000'
800'
5.5 Ac.
600'

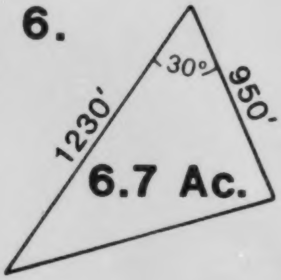
4.


960'
12.6 Ac.
1140'

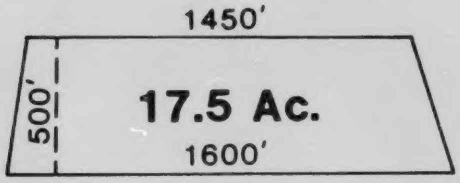
5.


920'
8.9 Ac.
90°
840'

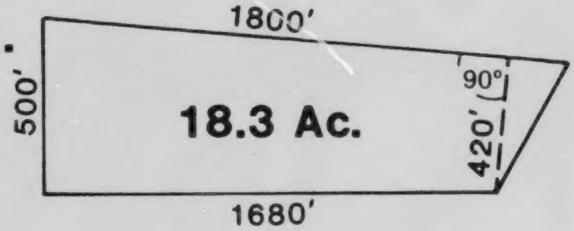
6.


30°
1230'
950'
6.7 Ac.

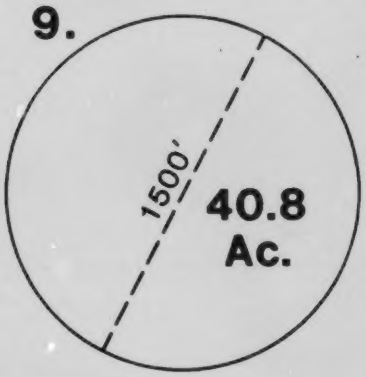
7.


1450'
500'
17.5 Ac.
1600'

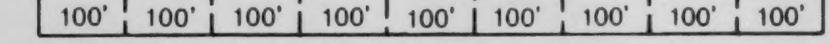
8.


1800'
500'
90°
18.3 Ac.
420'
1680'

9.



10.


5.6 Ac.
220'
240'
290'
310'
320'
325'
315'
270'
235'
180'
100'
100'
100'
100'
100'
100'
100'
100'
100'

TEACHER'S KEY

WORKSHEET #4

USING THE TRIPOD LEVEL

1. How is the instrument most safely transported?
   By carrying the instrument in the box.
   (Refer to filmstrip 438 A)

2. What is done with the lens cap? Tripod cap? Put both in the instrument case.

3. Where is the instrument box placed?
   Place it so it will not be damaged--possibly under the tripod.

4. What care should be taken before moving the tripod?
   Loosen the tripod screws and check to make sure the instrument is securely fastened to the tripod.

5. Why should an instrument never be leaned against a fence or building?
   It could fall and damage the instrument.

6. What should be used to support the tripod legs if set up on a floor?
   A triangle frame or a T-frame

7. How securely should the leveling screws be drawn? Until they are snug.

8. What is done to the leveling screws before returning to the box?
   Screwed back into the instrument.

9. How should the instrument be carried out of doors? When in the open, the instrument can be carried on the shoulder; when in close spaces, carry under the arm with the instrument in front.

10. How should the instrument be carried inside or through shrubs and bushes? Under the arm with the instrument in front.

11. What is the correct way to cross a fence with an instrument?
    Spread the tripod legs and place the instrument securely on the far side of the fence.

12. When is the sunshade used?
    At all times, when outside.

13. How are the lenses cleaned?
    With soft tissues. Never remove the lens.

TEACHER'S KEY
WORKSHEET #5

DIFFERENTIAL LEVELING

1. What is differential leveling?
   The process by which relative elevations of several points may be determined.

2. Explain the process of differential leveling. See Page 14 of VAS Unit 3010a

3. What is allowable error? A reasonable error made in surveying

4. How is allowable error calculated? Allowable ERROR = .14 times the square root of the length of traverse in feet divided by 100.

5. Record the following data in standard form as it would appear in a field notebook. These statements represent brief descriptions of the activities performed by tbe surveying party.

   a. Prepared to do differential leveling on the John Farmer farm located in the E 1/2 of the NW 1/4, Section 24, T6N R3E 3rd PM.

   b. Set up instrument and leveled it.

   c. Took sight on bench mark #1. . . 5.24'

   d. Took sight on turning point #1. . .6.35'

   e. Moved instrument and leveled it.

   f. Took sight on T.P. 1. . .4.83'

   g. Took sight on T.P. 2. . . 5.03'

   h. Moved instrument

   i. Took sight on T.P. 2. . .1.31'

   j. Took sight on T.P. 3. . .3.52'

   k. Moved instrument

   l. Took sight on T.P. 3. . .5.07'

   m. Took sight on T.P 4. . .4.73'

   n. Moved instrument

   o. Sighted on T.P. 4. . .4.61'

p. Sighted on point A. . .3.57'

q. Sighted on T.P. 5. . .2.32'

r. Moved instrument

s. Sighted on T.P. 5. . .3.11'

t. Sighted on T.P. 6. . .2.46'

u. Moved instrument

v. Sighted on T.P. 6. . .5.91'

w. Sighted on B.M. 1. . .6.65'

The following is a sketch of the location of the bench marks and turning points. This information is to be appropriately recorded and also used to determine if the error is a reasonable amount.

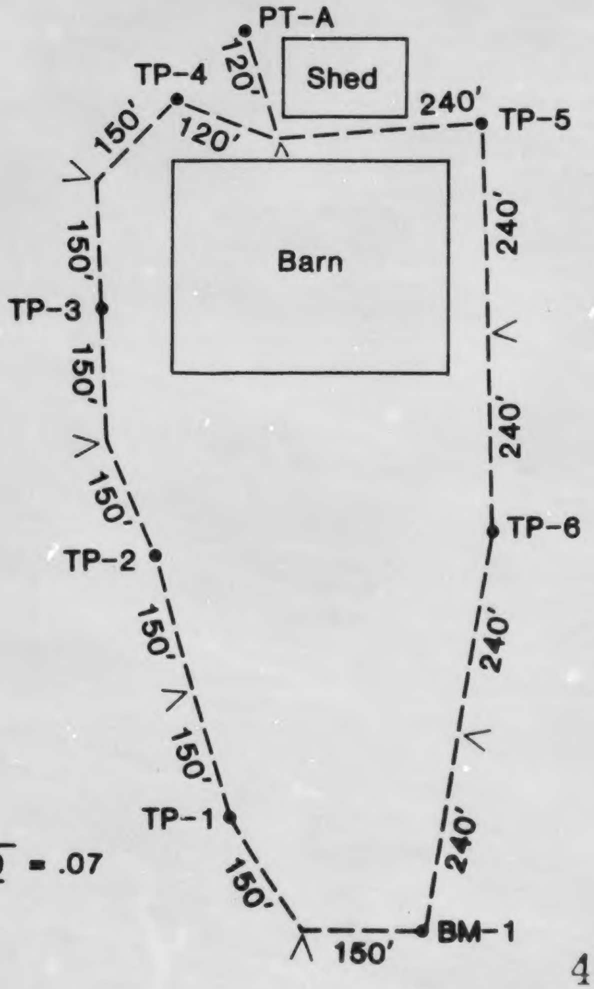
STA	BS	HI	FS	EIEV
BM-1	5.24			100
		105.24		
TP-1	4.83		6.35	98.89
		103.72		
TP-2	1.31		5.03	98.69
		100.00		
TP-3	5.07		3.52	96.48
		101.55		
TP-4	4.61		4.73	96.82
		101.43		
PointA			3.57	97.86
TP-5	3.11		2.32	99.11
		102.22		
TP-6	5.91		2.46	99.76
		105.67		
BM-1			6.65	99.02

John Farmer Farm

E 1/2 of the NW 1/4 ϕ

Section 24 ⊼

T6N R3E 3rd P.M. Rec.


PT-A
Shed
TP-4
120'
120'
240'
TP-5
150'
Barn
150'
240'
TP-3
150'
240'
150'
TP-6
TP-2
150'
240'
150'
TP-1
240'
150'
BM-1
150'

$.14\sqrt{\frac{2490}{100}} = .07$

6. From the following descriptive notes, make appropriate entries in standard form. (Vocational Agriculture Service field notes for surveying). Label columns correctly and make all calculations necessary to complete a differential leveling problem.

   a. Set up the instrument and leveled it.

   b. Took a sight on bench mark 1. . .4.36'

   c. Took a sight on turning point 1 . . .5.32'

   d. Moved instrument

   e. Sighted on T.P. 1. . .5.81

   f. Sighted on T.P. 2. . .3.41'

   g. Moved instrument

   h. Sighted on T.P. 2. . . 7.33'

   i. Sighted on point A. . .4.25'

   j. Sighted on T.P. 3. . .6.23'

   k. Moved instrument

   l. Sighted on T.P. 3. . .4.20'

   m. Sighted on B.M. #1. . .6.73'

STA	BS	HI	FS	EIEV
BM-1	4.36			100
		104.36		
TP-1	5.81		5.32	99.04
		104.85		
TP-2	7.33		3.41	101.44
		108.77		
Pt-A			4.25	104.52
TP-3	4.20		6.23	102.54
		106.74		
BM-1			6.73	100.01

TEACHER'S KEY

WORKSHEET #6

PROFILE LEVELING

1. What is meant by profile level? Determines elevation of a series of points at measured intervals along a line.

2. Where is profile leveling used?
Tile lines and drainage ditches

3. Explain the process of profile leveling.
See Page 16 VAS Unit 3010a

4. Work out the following profile survey and figure the grade elevation, cut and width of a surface drain to drain point 4+00 into point 0+00 using a 5:1 side slope on the ditch.

Station	Back Sight	Height of Instrument	Fore Sight	Elevation	Grade Elevation	Cut/ Fill	Width
BM - 1	2.06	52.60		50.00			
0+00			6.60	46.00	46.00	0	0
0+50			6.40	46.20	46.20	0	0
1+00			6.10	46.50	46.40	.10	1.0
1+50			5.40	47.20	46.60	.60	6.0
2+00			5.20	47.40	46.80	.60	6.0
TP - 1	8.05	51.00	9.65	42.95			
2+50			3.40	47.60	47.00	.60	6.0
3+00			2.80	48.20	47.20	1.00	10.0
3+50			3.10	47.90	47.40	.50	5.0
4+00			3.40	47.60	47.60	0	0
TP - 2	7.94	53.08	5.86	45.14			
BM - 1			3.08	50.00			

5. Work out the following profile survey and figure the grade elevation cut or fill and width of a surface drain to drain from 3+0 to 0+00 using a 5:1 side slope on the ditch.

Station	Back Sight	Height of Instrument	Fore Sight	Elevation	Grade Elevation	Cut/ Fill	Width
BM - 1	5.62	105.62		100.00			
0+00			3.12	102.50	102.50	0	0
0+50			3.80	101.82	103.00	+1.18	11.8
1+00			4.46	101.16	103.50	+2.34	23.4
1+50			5.06	100.56	104.00	+3.4	34.0
TP - 1	5.32	106.32	4.62	101.00			
2+00			2.93	103.39	104.50	+1.11	11.1
2+50			1.68	104.64	105.00	+.36	3.6
3+00			0.82	105.50	105.50	0	0
TP - 2	4.16	104.16	6.32	100.00			
BM - 1			4.16	100.00			

6. Work out the following profile survey for a surface drain using a 5:1 side slope on the ditch.

Station	Back Sight	Height of Instrument	Fore Sight	Elevation	Grade Elevation	Cut/ Fill	Width
BM - 1	4.50			100.00			
		104.50					
0+00			8.02	96.48	96.480	0	0
0+50			7.85	96.65	97.056	+.40	0
1+00			6.42	98.08	97.632	+.448	4.48
TP - 1	7.28		7.77	96.73			
		104.01					
1+50			5.03	98.98	98.208	.772	7.72
2+00			4.72	99.29	98.784	.506	5.06
2+50			4.31	99.70	99.360	.340	3.40
3+00			4.07	99.94	99.936	.004	.04
TP - 2	5.37		3.91	100.10			
		105.47					
BM - 1			5.42	100.05			

TEACHER'S KEY

WORKSHEET #7

USING THE HAND LEVEL

1. Explain how a contour line can be found with the hand level.

   See Pages 11-12 VAS, Unit 3010a

2. Explain how slopes can be measured using the hand level.

   See Pages 11-12 VAS, Unit 3010a

3. If your eye level is 5 feet determine the percent slopes on the following readings: The distance read is 25 feet.

A - 5'6"	2%
B - 4'8"	1%
C - 3'	8%
D - 4'1"	4%
E - 5'0"	0%
F - 4'10"	71%
G - 2'1"	12%
H - 1'3"	15%
I - 2'6"	10%
J - 1'4"	15%

TEACHER'S KEY

WORKSHEET #8

STAKING OUT A BUILDING FOUNDATION

1. How can new building locations be found with a surveying instrument?

   See Pages 19-21 VAS, Unit 3010a

2. Explain how, in a step by step method, you would lay out a building site for a proposed implement shed to be built if the owner wants it 20 feet south and 20 feet east of the barn. The building will be 60 X 20 in size with an east entrance.

   a. Set two stakes twenty feet from east side of barn, one at N.E. corner and one at S.E. corner.

   b. Establish parallel line 20 feet from east side of barn.

   c. Use steel tape to measure 20 foot distance south of barn on parallel line and set 2 x 2 stake for N.W. corner of new shed.

3. Explain, step by step, how you would lay out a fence at a 90° angle from an existing fence.

   refer to VAS Unit 3010a, page 21

4. What is the method of assuring that your building layout is "square?"

   refer to VAS Unit 3010a, page 19

Questions Refer to filmstrip 439A

5. Where are new farm buildings usually located?

   (refer to frame 4)

6. How is the level located over an exact point?

   (refer to frames 6-13)

7. Name as many items as you can that are needed to stake out a building.

   (refer to frame 15)

8. How can the convertible level be used to extend a line?

   (refer to Frames 18-20)

9. How can the convertible level be used to mark off a 90° angle?

   (refer to frames 21-23)

10. How can a building site be checked to be sure it is rectangular?

    (refer to frame 24)

11. What is the purpose of batter boards?

    (refer to frame 25)

12. Describe how the level is used to set the batter boards at the desired height.

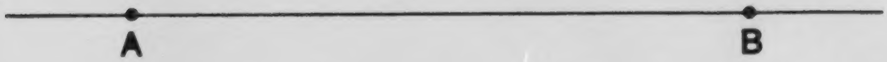
    (refer to frame 25)

13. How are batter boards marked to preserve the correct location of the strings?

    (refer to frames 29-30)

14. Describe procedure for locating the four corners of a building, 40' x 90', with the long side being located from point A along the line toward B.

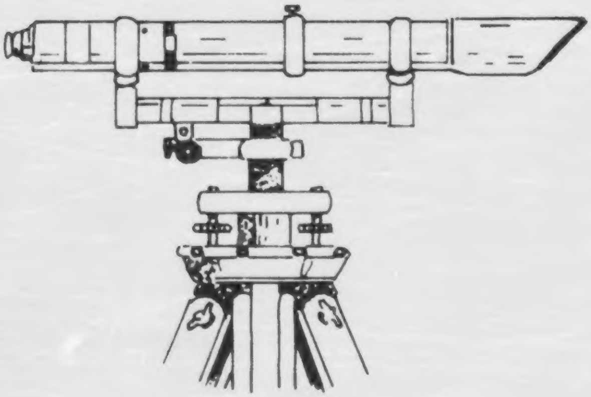
refer to VAS Unit 3010a, pages 18, 19



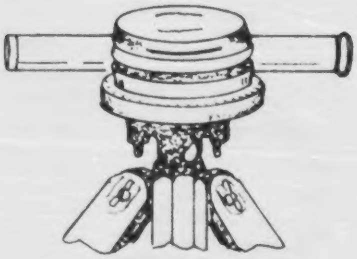
15. Explain and show by diagram how batter boards and string would be used to stake out a building foundation with corners EFGH as shown below.

refer to VAS Unit 3010a, pages 19, 20

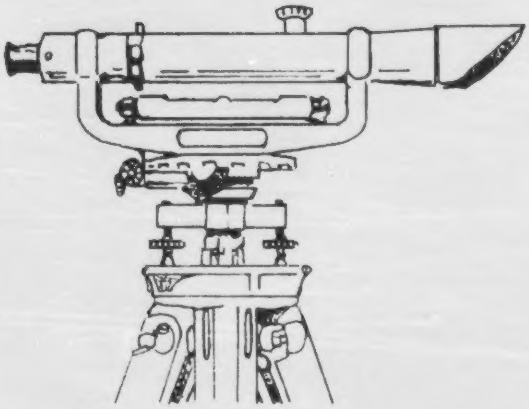
TYPES OF LEVELS



Engineer's Dumpy

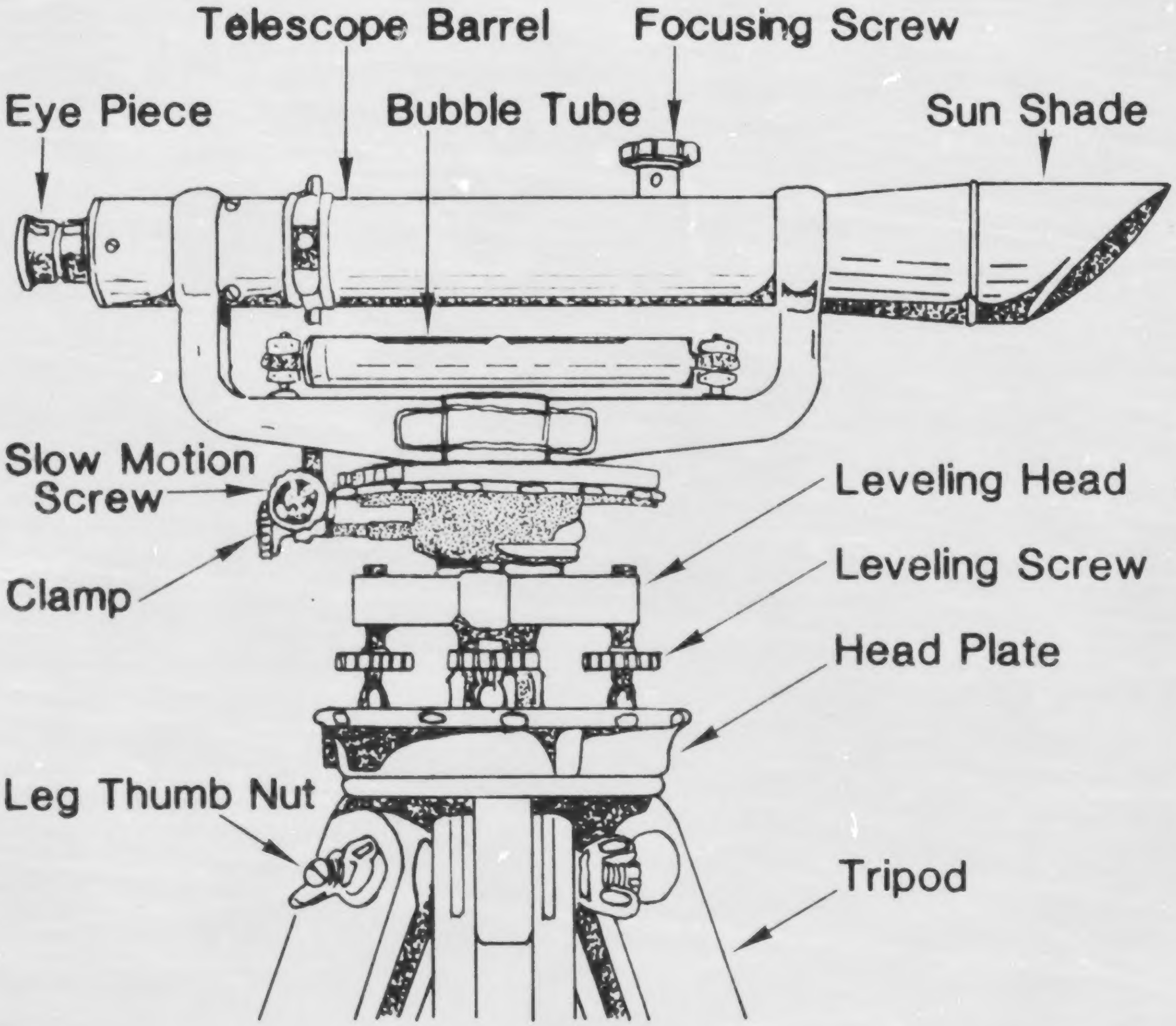


Turret

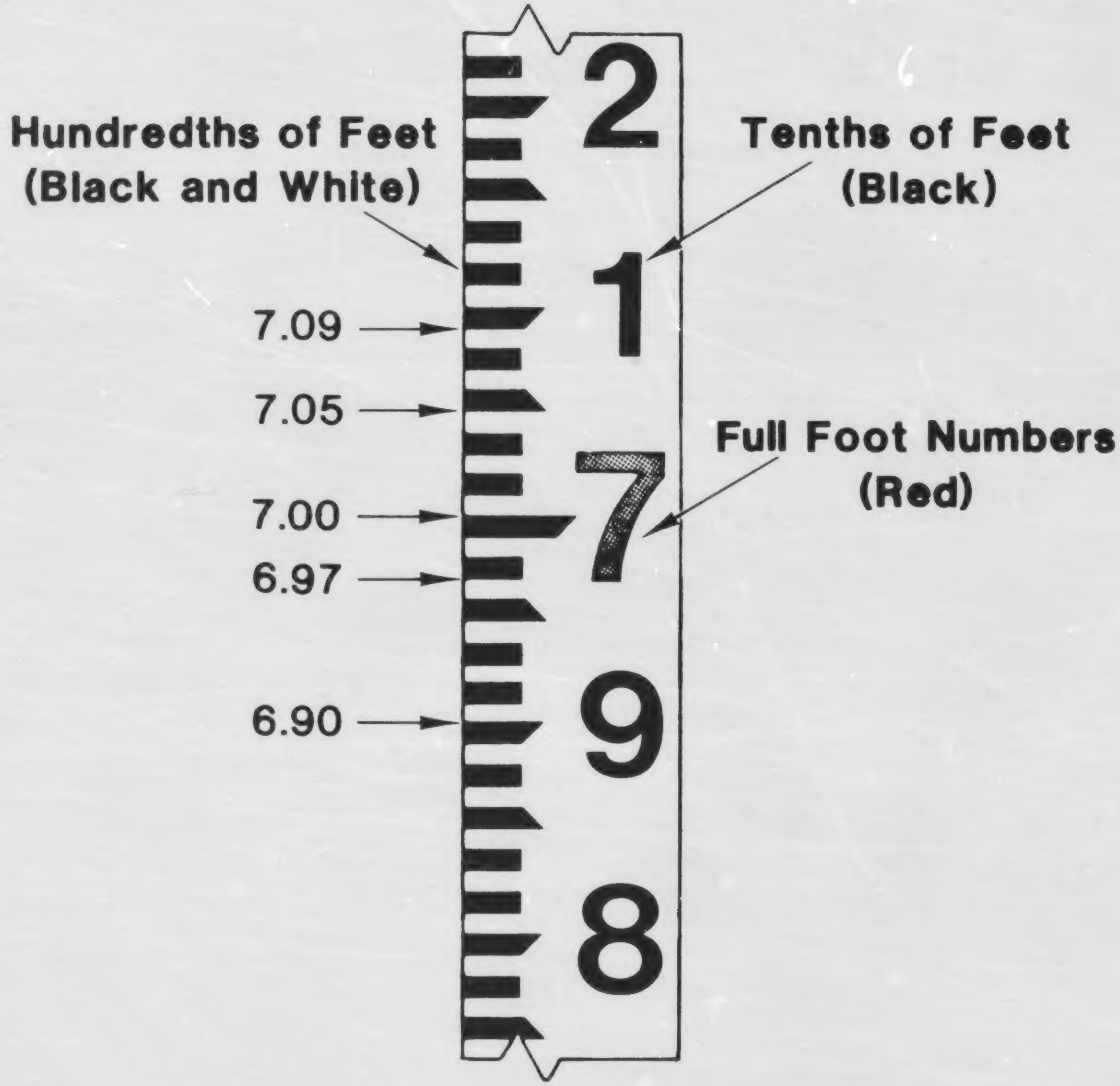


Builder's

PARTS OF THE LEVEL

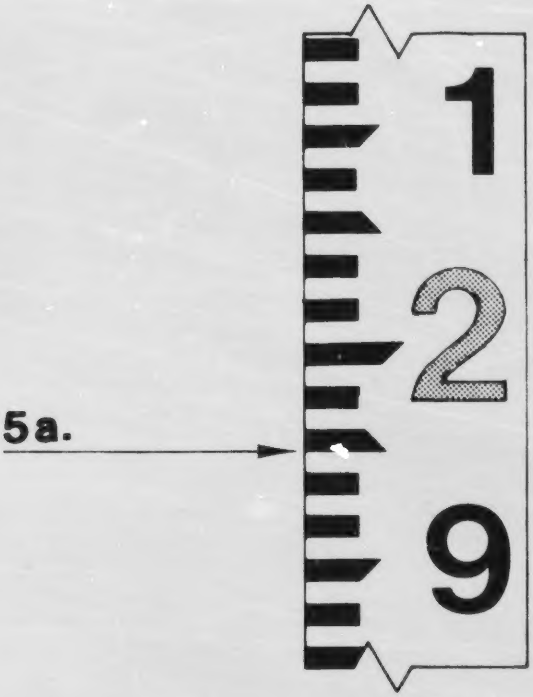

Telescope Barrel
Focusing Screw
Eye Piece
Bubble Tube
Sun Shade
Slow Motion Screw
Leveling Head
Leveling Screw
Clamp
Head Plate
Leg Thumb Nut
Tripod

SELF-READING ROD

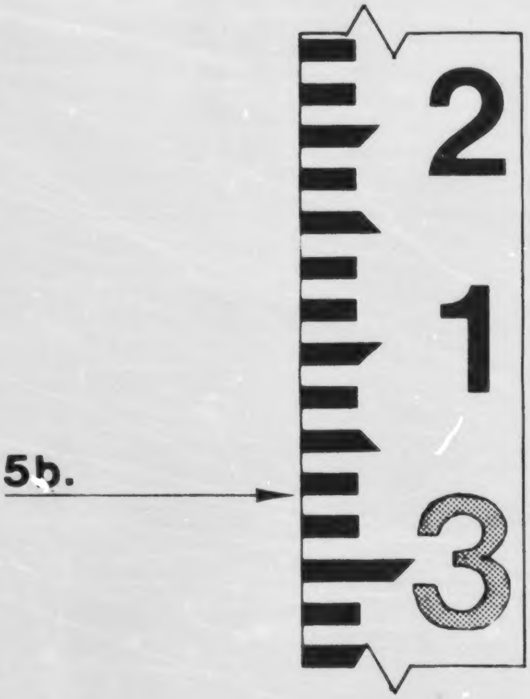

Hundredths of Feet
(Black and White)
Tenths of Feet
(Black)
Full Foot Numbers
(Red)
7.09
7.05
7.00
6.97
6.90
2
1
7
9
8

SELF-READING ROD WORKSHEET

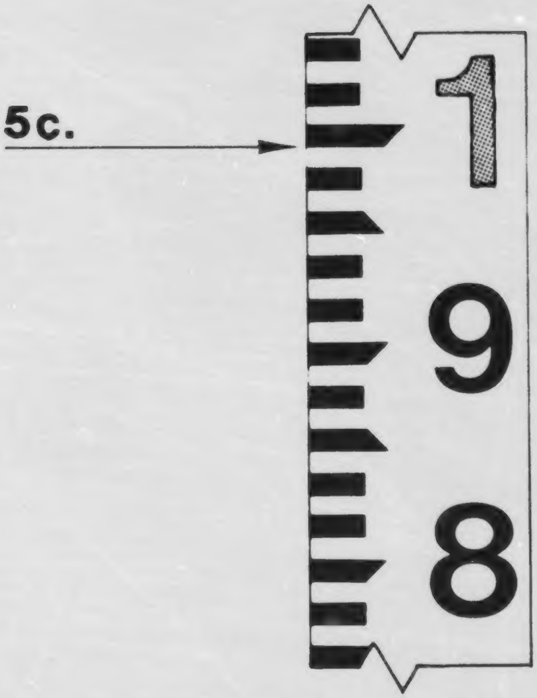
5a.



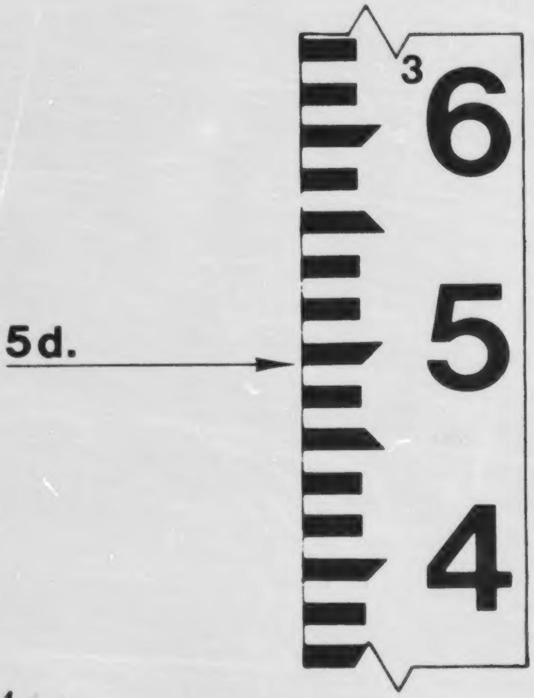
5b.



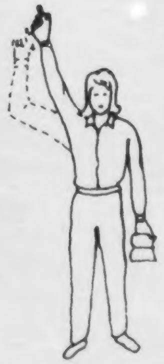
5c.



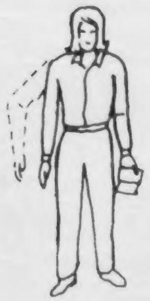
5d.



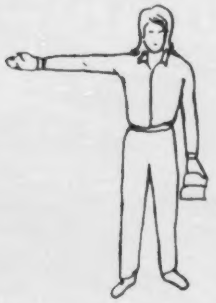
HAND MOTIONS



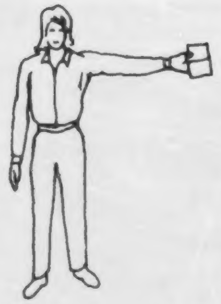
Move up



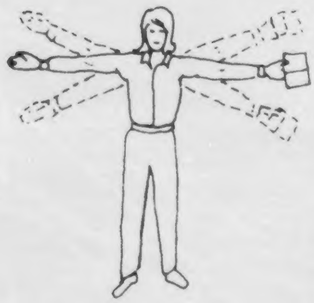
Move down



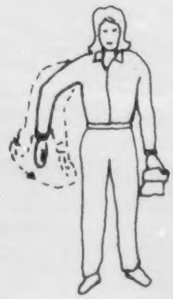
Move rod
to the right



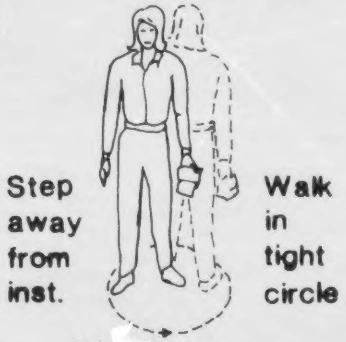
Move rod
to the left



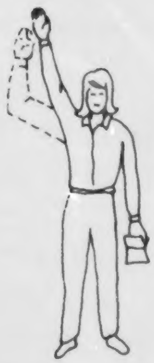
Observation completed
or Move on
or Understood



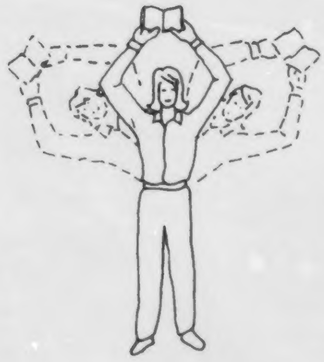
Come in


Step
away
from
inst.
Walk
in
tight
circle

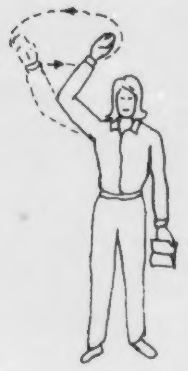
Wrong face
or Check clamp
or Rod upside down



Use long rod



Wave rod from
side to side



Turning point

DISCUSSION GUIDE FOR TRANSPARENCIES

I. Transparency: SURVEYING LEVELS

A. Types of Levels:
1. Identify the common types of levels.

2. Point out that levels vary considerably in cost.

3. The types range from the simple farm level, to the builder's level, to the engineer's level.

B. Parts of the Level:
1. Point out that it is necessary to be familiar with the parts of a level so you will know how to set it up and adjust it.
2. Discuss how all levels have essentially the same parts;
   a. telescope
   b. leveling device (point out screws)
   c. leveling plate
   d. tripod

3. Point out that the wye level has a removable telescope and the dumpy level's telescope cannot be removed.

II. Transparency: SURVEYING RODS

A. Parts of the Surveying Rod:
1. Point out that the distance between each black and white line is 1/100 of a foot in width.
2. Top of black lines are even 100ths of a foot.
3. The rod is graduated in feet, tenths, and hundredths.
4. The red numbers are feet and the black numbers are tenths of a foot and not inches.

B. Reading the Rod:
1. Use these transparencies to explain and demonstrate how to read a surveying rod.
2. Explain how to determine a percent slope using a hand level height or a tripod height of instrument.

III. Transparency: HAND SIGNALS
1. Demonstrate each hand signal.
2. Explain why hand signals are used in surveying.

TEACHER'S KEY

SURVEYING

SAMPLE TEST QUESTIONS

1. An acre is equal to (43,560) square feet.
2. Most steel tapes are (100) feet long.
3. (Backsights) are also known as plus sights.
4. A (bench mark) is permanent point of known or assumed elevation from which leveling surveys are started.
5. The operation by which the relative elevation of several points the same distance apart are determined is known as differential leveling.
6. (Fore sights) are also known as minus sights.
7. (Fore sights) is a level reading taken on a point of unknown elevation.
8. The (head rear) tapeman carries the 100' end of the tape.
9. The (head rear) tapeman carries the ring and pins when starting the measure.
10. The elevation of the line of sight is called the (height of instument).
11. The sunshade should be used (only when the sun shines, all of the time).
12. When adjusting the level, the bubble will follow the (left) thumb.
13. To establish contour lines one uses a (hand level).
14. To establish a line at right angles to another line, you could use two methods with a tape. They are (3-4-5 Method) or (Chord Method).
15. Farm levels may be classified as (dumpy) levels or (wye) levels.
16. A (backsight) is a reading taken on a point of known elevation.
17. Subtract the (fore sight) from (height of instrument) to determine elevation at a location.
18. Add the (backsight) to the elevation of a location to determine (height of instrument).

19. A rod is (16.5) feet long.

20. A chain is (66) feet long.

21. (Profile leveling) is the process of determining the elevations of a series of points at measured intervals along a line.

22. The (two peg test) is used to check the accuracy of the instrument.

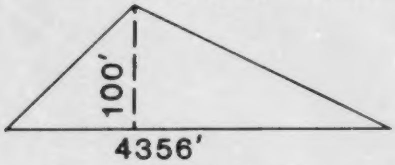
23. (Profile leveling) is used to determine grade elevations for drainage ditches, tile lines, etc.

24. The rod used in surveying is marked off in (feet), (tenths), and (hundredths.

(C) 25. To find the area of a figure with four sides, none parallel; divide it into ______________ and determine the area of these ________________ separately.
- a) a square. . . 4 triangles
- b) 2 trapezoids. . . 2 trapezoids
- c) 2 triangles. . . 2 triangles
- d) 4 triangles. . . 4 triangles

26. What is the area of a field with these dimensions? (Answer in acres).

(50 acres)



T 27. A tripod is part of a surveying instrument.

F 28. The height of the instrument is the elevation of a point on which the instrument is setting.

T 29. A surveying level is quite useful in staking out and checking the construction of a building foundation.

T 30. When adjusting the instrument the bubble follows the left thumb.

F 31. The lens of an instrument gets wet, dry it with a rag.

F 32. When taping, the number of pins in the rear tapeman's hand plus the one in the ground indicates the number of 100 foot lengths that have been measured.

T 33. In plan surveying all distances measured on the earth's surface are considered to be on horizontal lines.

T 34. A hand level is most commonly used for locating contour lines.

F 35. The area of a trapezoid equals the product of the sum of the two parallel sides times the altitude.

F 36. The telescope of the dumpy level is removable.

T 37. The area of an irregular shaped figure, calculated by the trapezoid rule is an approximation of the real area.

T 38. Angles may be measured on the ground by using the tape and trigonometric table.

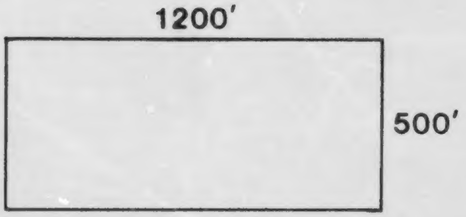
F 39. The chord method uses the altitude of an isoceles triangle to determine a right angle.

F 40. When taping, a 3-5-7 right triangle could be used to erect a perpendicular with respect to another line.

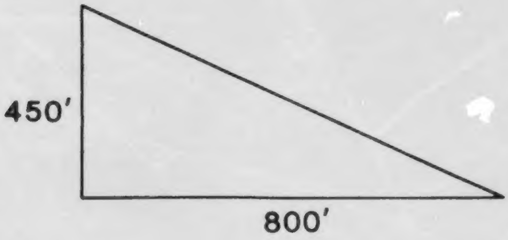
F 41. When determining the percent of slope, the 100 foot distance is measured down the hill and the difference in elevation in feet is equal to the percent of slope.

T 42. When using a self reading rod, the even hundredths of a foot are the top of the black lines.

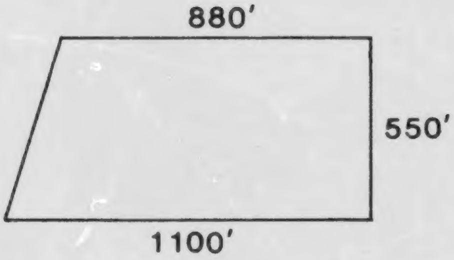
DETERMINE THE FOLLOWING ACRES



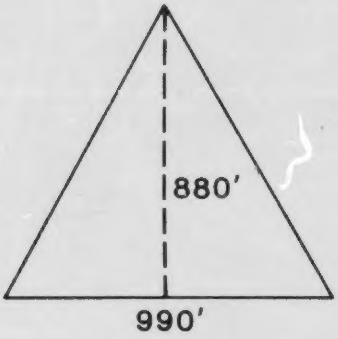
43. (13.77A.)



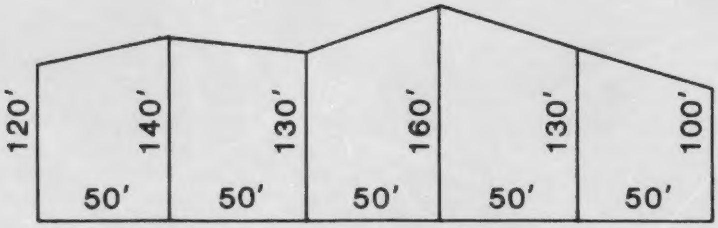
44. (4.13A.)


880′
550′
1100′

45. (12.5A)



46. (10.0A.)


120′
140′
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160′
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47. (.769A.)

48 - 53. Correctly label the columns.

54 - 69. Correctly fill in the columns.

Station	Back Sight	Height of Instrument	Fore-Sight	Elevation	Dist.
B.M. - 1	5.02			300	
		305.02			250
TP - 1	4.50		5.58	299.44	
		303.94			270
TP - 2	4.20		4.25	299.69	
		303.89			330
TP - 3	7.09		1.11	302.78	
		309.87			300
TP - 4	6.23		2.00	307.87	
		314.10			320
TP - 5	12.10		.94	313.16	
		325.26			350
TP - 6	2.77		3.90	321.36	
		324.13			410
TP - 7	2.27		1.40	322.73	
		325.00			380
TP-8	.71		13.15	311.85	
		312.56			400
BM-1			12.50	300.06	
					3010

70. The allowable error is (.08').

UNIT H: AGRICULTURAL MECHANICS

PROBLEM AREA: DEVELOPING BASIC SHOP SKILLS

SUGGESTIONS TO THE TEACHER:

This problem area is designed for use with tenth-grade or second-year students enrolled in an agricultural occupations program. The recommended time for teaching this problem area is during the early winter and before students start building their own projects. The estimated time for teaching this problem area is 25 to 30 days depending on how much time the teacher wishes to spend on discussion and conducting the suggested exercises. The materials in this problem area were selected and written with the following assumptions:

1. Students have completed and successfully passed a shop safety evaluation.
2. The teacher should accomplish the following prior to teaching the problem area:
    a. Identify the tasks to be taught and construct a work chart on poster board; list time and exercise across top (one week/skill) and students name down right side, fill in grid with the exercise to be completed (stagger skills so students are all doing something different).
    b. Secure and arrange all necessary materials in a store room. This can be completed prior to school starting in the fall.
    c. Make any preliminary rough cuts of the material.
    d. Duplicate selected Job Sheets and place in a file folder along with necessary references. Label and locate them in a file drawer so students can have access to them.
    e. Selected welding and woodworking exercises can also be added to this problem area.

The instructor is encouraged to conduct a local search to locate other supplementary materials. The items in this problem area are for reference or modification as the teacher adapts this problem area to his/her local situation.

CREDIT SOURCES:

The materials were developed through a funding agreement, R-33-32 D-0542-388 with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, Research and Development Section, 100 North First Street, Springfield, Illinois 62777. Opinions expressed in these materials do not reflect, nor should be construed as policy or opinion of the Illinois State Board of Education or its staff.

The teacher's guide, job sheets, and transparency discussion guide, were developed by Jerry Pepple, Department of Vocational and Technical Education, University of Illinois. The transparency masters and drawings were prepared by Vocational Agriculture Service, University of Illinois.

Suggestions and guidance in the development of these materials were provided by the Rural Core Curriculum Pilot Test Teachers.

TEACHER'S GUIDE

I. Unit: Agricultural mechanics

II. Problem area: Developing basic shop skills

III. Objectives: At the conclusion of this problem area students will be able to:

1. Correctly sharpen wood chisels.
2. Sharpen twist drill bits within proper clearance angles.
3. Use selected cold metal working tools and marking and measuring instruments.
4. Shape and temper carbon steel by use of a forge or acetylene torch and anvil.
5. Mark, shape, drill, thread, and cut cold metal.
6. Mark, cut, thread, and connect various types of plumbing pipe.
7. Identify the steps and properly complete the task of removing and replacing glass in a window frame.

IV. Suggested interest approaches:

1. Review with the class the important reasons for needing to know how to perform selected basic shop tasks before they go to the shop to build their own projects.
2. Give class a brief overview of what is to be covered in this problem area. Explain how this instruction will help them when they work at home or when working on their own projects.
3. If some students have had experience in some of the skill areas, review what they have done and why and when they had to perform the tasks.
4. Ask students to report any instances where they could use these skills at home or with their S.O.E.P.'s.

V. Anticipated problems and concerns of students:

1. How long will I have to complete each skill exercise?
2. What criteria will be used to determine the grade of each skill assignment?
3. When will I get the materials to do each skill?
4. Will all students be working on the same exercises at the same time?

5. Can I take the completed project home after it is graded?

6. What can I do if I do not complete the exercise within the specified time?

7. What shop clothes and/or equipment will I need to bring before I can start working on these exercises?

8. How do I know what procedures to follow in completing each skill exercise?

9. Where will the assignment sheets be kept?

10. Will I have the opportunity to re-do an exercise if I get a low grade on it?

11. What will happen if I am absent and don't finish an exercise?

VI. Suggested learning activities:

1. Begin the instructional phase of this problem area with the following steps:
    a. Introduce the problem area by conducting an interest approach.

    b. Assist the students in identification of goals and objectives for this problem area.

    c. Have students identify their problems and concerns.

    d. Discuss and answer these problems and concerns by explaining the procedure and information which will be used during this problem area.

2. Place poster board which lists the selected skill exercises and assignments on bulletin board. Explain how the assignments are arranged (refer to "Suggestions to the Teacher," at the beginning of this problem area) and the exercise will be due each Friday.

3. Establish a point value for each skill exercise. A ten point system could be used and a student would receive a grade between zero and ten each week, (i.e. 5, 8, 3.5, 7.5, 9.5, etc.). These weekly grades could be recorded on the poster board if the student do not object to their grades being publicly posted.

4. Review shop safety procedure with the students before letting them start the exercise.

5. Take the class on a tour of the shop pointing out the various work stations for each exercise, the storage area where the supplies are sorted and kept which are to be used for the skill exercises, and if necessary where the various shop tools are located.

6. If needed, demonstrate the uses of selected shop equipment before the entire class, then explain that you will be providing individualized instruction as needed during the shop skill exercises.

7. Have each student identify his/her first assignment. They should then go to the file drawer and obtain one copy of the job sheet in the assigned folder. The students should read and follow the suggested procedure outlined on each job sheet.

VII. Application procedure:

1. The main purpose of this problem area is to familiarize students with how to correctly use selected shop tools and perform basic home and shop skills. These exercises were not primarily concerned with the construction of a project but with the learning of numerous basic skills and abilities with a limited time frame.

2. Students should be able to use and apply these skills to various phases of their S.O.E.P. and general home maintenance projects.

VIII. Evaluation:

1. Collect and grade each exercise every week.

2. Evaluate students general shop attitude.

3. Evaluate student attendance.

4. Collect and grade the questions in the job sheets.

IX. References and aids:

Refer to the material list given on each of the Job Sheets you have selected for the students to do. Allow for waste and the number of students in the class when ordering material.

JOB SHEET 1

SHARPENING-WOOD CHISELS

OBJECTIVES:

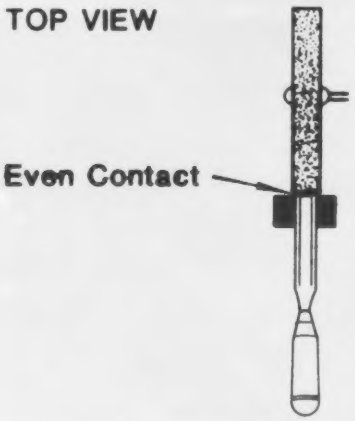
1. To develop the ability to properly sharpen and recondition wood chisels by using grinding wheels and whetstones.
2. To develop the ability to properly dress and true a grinding wheel.

MATERIAL:

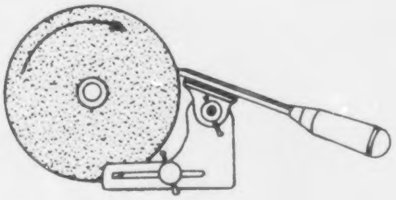
1. Power grinder
2. Dulled wood chisel
3. Oilstone
4. Light oil
5. VAS Unit 3005, Sharpening Hand Tools

PROCEDURES:

1. Joint the chisel if it is nicked, rounded, or not square by nolding the chisel level with the cutting edge at right angles against the grinding wheel.



2. Set the tool rest at an angle of 25-30 degrees and lay the chisel on the tool rest and lightly grind the edge keeping the chisel perpendicular to the face of the grinding wheel.

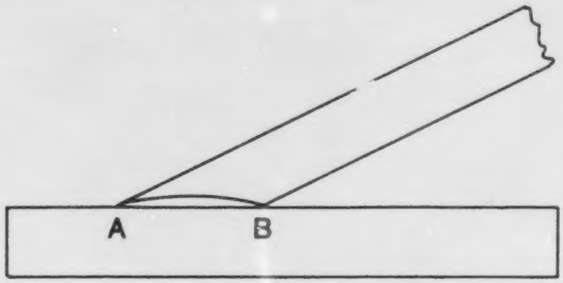


3. Dip the edge in water frequently to keep it cool and to examine the edge for sharpness.

4. Continue grinding until a slight wire edge develops on the back side of the chisel.

5. Save the wire edge off the chisel by using oilstone and light weight oil. Lay the chisel flat on the oilstone with the level side up and lightly grind the chisel.

6. Place the bevel side down on the oilstone and rock it back and forth to be sure it touches the oilstone at points A and B. Move chisel back and forth. Use more pressure on the forward stroke and release the pressure on the backward stroke.



7. After honing, remove any wire edge and check for sharpness.

QUESTIONS:

1. What is meant by jointing a wood chisel?

2. What bevel angle is recommended for fine work or soft wood?

3. Describe how to use a carpenters square and a sliding T-bevel square to set a tool rest at a 25 degree angle.

4. How can you determine if an edge is sharp after grinding?

After honing?

OBSERVATIONS:

Outline the procedure and results obtained with the exercises.

APPLICATION:

Practice using the wood chisel after you sharpened. Identify how this skill can be used to imporve your S.O.E.P.

JOB SHEET 2

SHARPENING TWIST DRILL

OBJECTIVES:

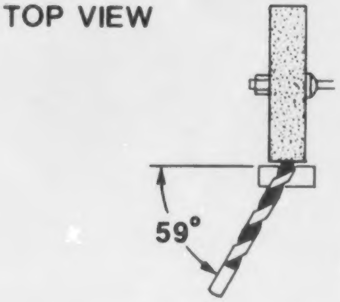
1. To develop the ability to properly sharpen and recondition twist drills by using grinding wheels.
2. To understand why proper angles are necessary for edge angles and lip clearance.

MATERIAL:

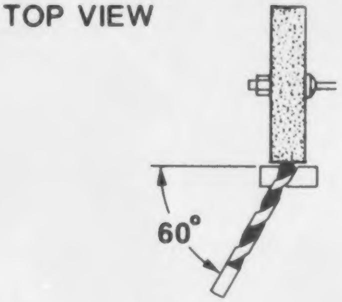
1. Power grinder
2. Dulled twist drill bit (3/8" - 1" in size), larger bits are easier to sharpen
3. VAS Unit 3005, Sharpening Hand Tools
4. Tool gauge (if available)

PROCEDURE:

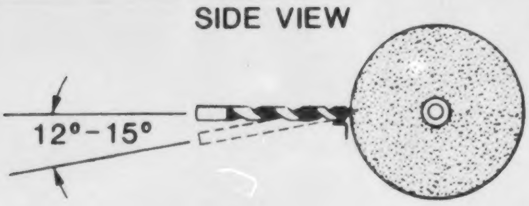
1. Place the bit on the tool rest with the axis of the bit at about a 60 degree angle with the face of the wheel.

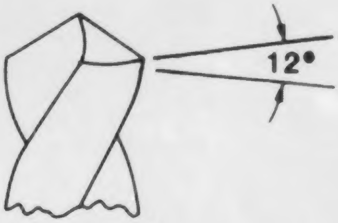


2. Use light pressure and a back and forth motion across the face of the grinding wheel. Continue until both edges are sharp, and equal in length, and of the proper anlge, about 60 degrees.

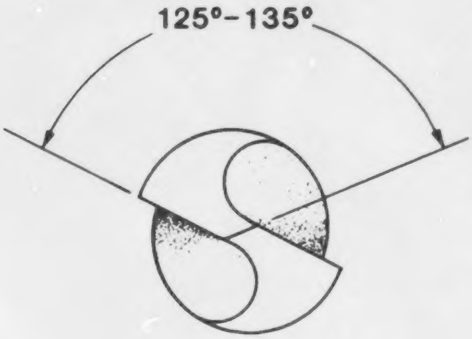


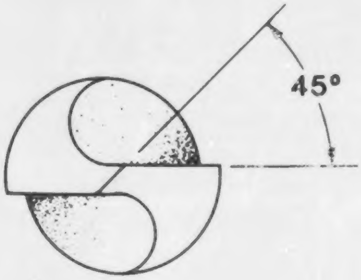
3. Grind a lip clearance of about 12 degrees by slightly moving the bit up the face of the wheel and gradually lowering the stem end of the bit. Rotate the bit slightly in a clockwise direction as you apply light pressure to the grinding wheel face. Grind both sides until you get about a 12-15 degree back slant to the edge line of the drills cutting edge.





4. Check the center angle clearance. It should have an angle of 120-135 degrees between dead center and either cutting lip. Or with the cutting edge at horizontal the center angle should be at about 45 degrees up from horizontal.





5. Dip the drill bit in water frequently to keep the edge cool.

QUESTIONS:

1. Describe the type of shavings which result from drilling with a sharp bit.

2. Why is it necessary to move the drill bit back and forth across the face of the grinding wheel?

3. Why is proper lip clearance important?

4. Why is the center line angle important?

OBSERVATIONS:

Outline additional procedures used in this exercise as explained by your instructor.

APPLICATIONS:

Try the sharpened drill bit on mild steel. What were the results?

JOB SHEET 3

CONSTRUCTING A TOOL SHARPENING GAUGE

OBJECTIVES:

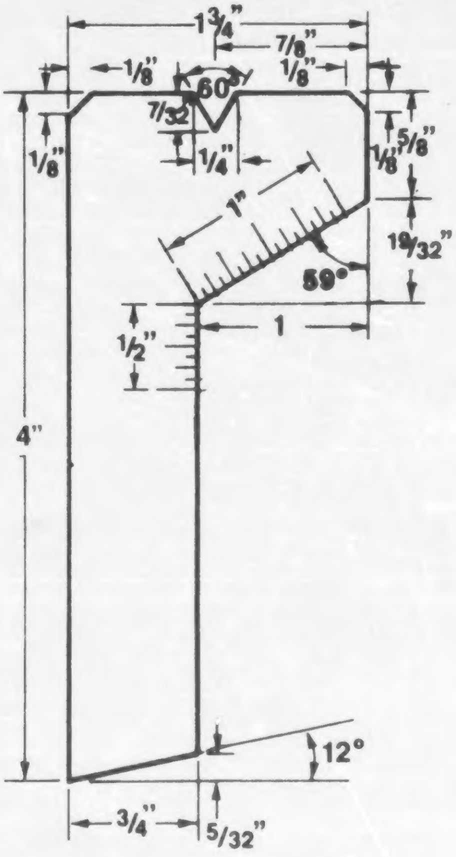
1. To develop the ability to measure and mark metal stock with rulers and awls.
2. To correctly cut, shape, and polish metal stock by using hacksaws, metal files and steel wool.

MATERIAL:

1. Aluminum, brass, or soft steel stock 2" X 4½" X 3/32" (aluminum is easiest to work)
2. Marking rule
3. Awl
4. Hacksaw
5. Small try square or straight edge
6. Flat metal file and taper file
7. Steel wool
8. VAS Unit 3002a, Cold Metal Work

PROCEDURES:

1. Study the working drawing of the tool sharpening gauge.



2. Square one side and end of the gauge.

3. Measure and mark an outline of the gauge on the metal stock. Double check your measurements before you start cutting out the gauge.

4. Secure the stock in a vise using protective blocks to prevent scratching or bending metal when cutting out the gauge.

5. Dress the stock to the marking lines with a file and emery cloth.

6. Polish the gauge with steel wool.

QUESTIONS:

1. What was the pitch of the hacksaw blade you used? (refer to VAS Unit 3002a, pages 10-11)

2. What type of file did you use with this exercise? (refer to VAS Unit 3002a, pages 15-16)

3. What can this tool gauge be used for?

4. What other instruments can be used to mark metal?

OBSERVATIONS:

Describe how to properly use a hacksaw and a file when working with metal.

APPLICATIONS:

Identify any new techniques you learned by doing this exercise and how it may benefit your S.O.E.P.

JOB SHEET 4

CHAIN REPAIR LINK

OBJECTIVES:

1. To develop the ability to properly mark and drill holes in metal.
2. To develop the ability select and use a tap and die to thread metal.
3. To develop the ability to accurately mark, heat and bend metal.
4. To develop the ability to mark and cut metal with a hacksaw.

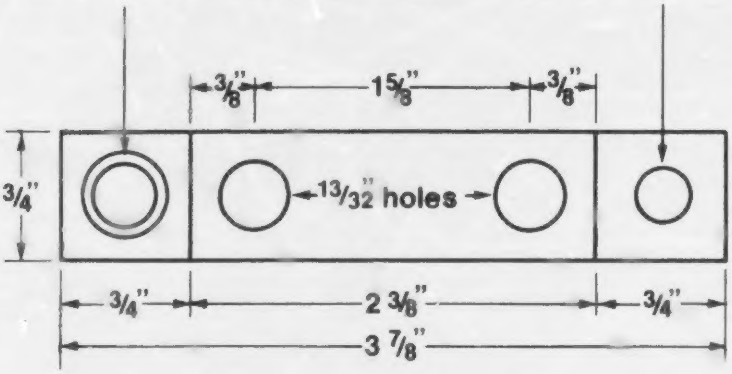
MATERIALS:

1. 3/8" rod 4" long
2. 1/4" X 3/4 flat iron 4" long
3. Tap and die set
4. Acetylene torch
5. Metal marking tools
6. Metal vise, pliers, and adjustable wrench
7. VAS Unit 3002a, Cold Metal Work

PROCEDURES:

1. Check the flat iron for length with a steel rule. The ends should be square, smooth, and the piece exactly 4" long.
2. Lay out exact dimensions of the flat iron piece and centers of holes with rule and awl.

Drill 5/16" holes and tap to 3/8"x16 N.C. Thread



NOTE: 4" piece leaves enough for hacksaw cuts.

3. Center punch holes accurately and drill the two outside holes 5/16" in size and the two inside holes 13/32" in size.

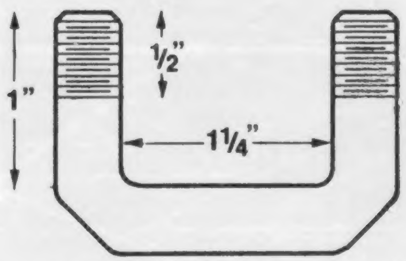
4. Tap out the two outside holes using a 3/8" X 16 N.C. thread. Use cutting oil on the taps when needed.

5. Use a hand hacksaw with the proper blade to cut off the nuts. The nuts should be 3/4" square and filed to the proper shape and smoothness.

6. Check rod for length with a steel rule. It should be 4" long and smooth and flat on the ends.

7. Mark rod 1" from each end. Place rod in metal vise and heat a narrow band until it is bright red with a gas torch. Use an adjustable wrench and bend the 1" piece to a right angle.

3/8" x 16 N.C. Thread



NOTE: Make bends hot in vice.

8. Thread down ½" on both ends of the rod. Use 3/8" X 16 N. C. tap. Use cutting oil on taps when needed.

9. Mark, heat, and bend the other end of the threaded rod. Use a smooth jawed adjustable wrench to avoid damaging the threads. Do not hammer on the threads.

10. Check for 1" length of legs and 1¼" distance between the legs. The U-shaped rod should fit in the holes on the 2 3/8" flat iron piece. The 3/4" taps should easily screw on to the ends of the rod.

Note: Always make the flat iron piece first, then make the U-bolt to fit. If the bolt does not easily fit into the flat iron holes. Use another rod and adjust the measurements for the bends. Make the bends as square as possible.

QUESTIONS:

1. What were the specifications of the hacksaw blade you used?

2. How did you mark the holes so they could be drilled exactly as needed?

3. What were the specifications of the file used for smoothing?

4. What do the following refer to in thread type?

   N.C

   N.F

   N.P.T.

OBSERVATIONS:

Briefly outline the correct procedure for (A) filing metal; (B) drilling holes; (C) tapping and threading metal.

APPLICATIONS:

How can these skills be applied to your S.O.E.P. or home shop?

JOB SHEET 5

GLAZING GLASS

OBJECTIVES:

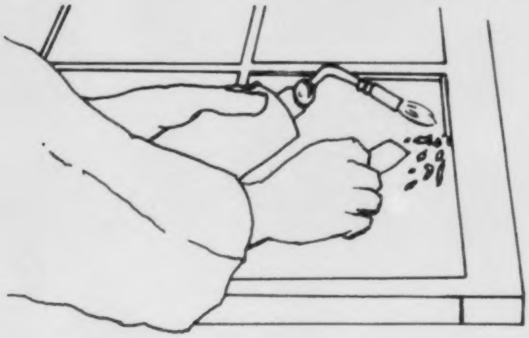
1. To develop the ability to identify necessary tools and equipment to complete a glazing job.
2. To develop the ability to perform a glazing job.
3. To be able to identify practical applications of glazing.

MATERIALS:

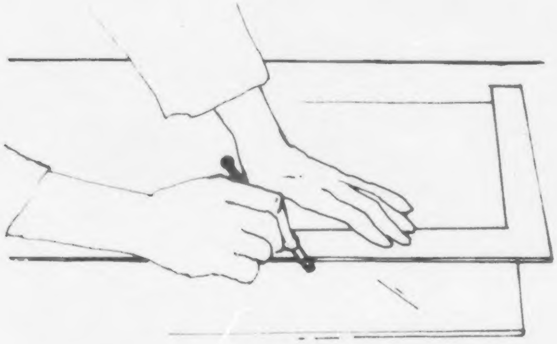
1. Glazing compound
2. Putty knife
3. Glass cutter
4. Glazier's points
5. Prepare torch (if removing old putty)
6. VAS Unit 3039, Glazing

PROCEDURE:

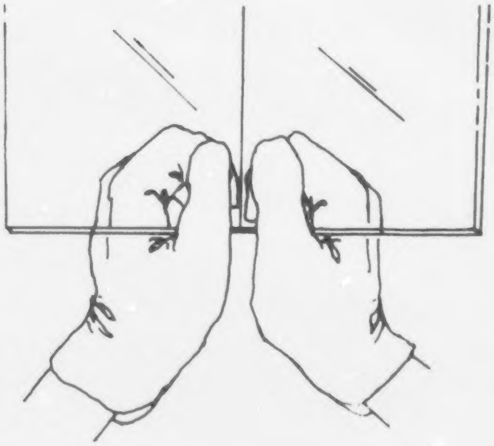
1. Remove old glass from window sash and all the old putty. A propane torch can be used to soften hardened putty. Use a putty knife or paint scraper to scrape out old putty in the sash. Use pliers to pull the glaziers' points from the wood.



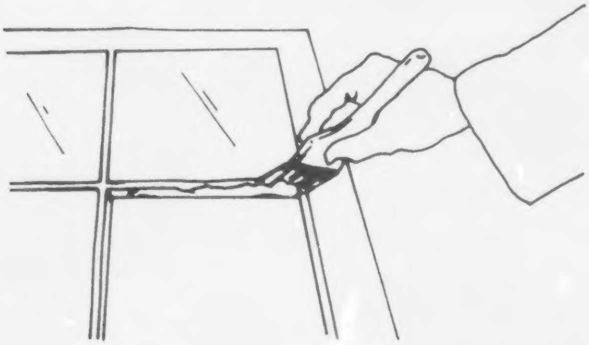
2. Measure the frame for the glass. Mark the glass at least 1/32 inch smaller on each side than the size of the frame. Cut a piece of paper the correct size and place it under the glass with a glass cutter in one continuous stroke. Dip the cutter in kerosene before cutting to reduce chipping. Use enough pressure to scribe the glass.



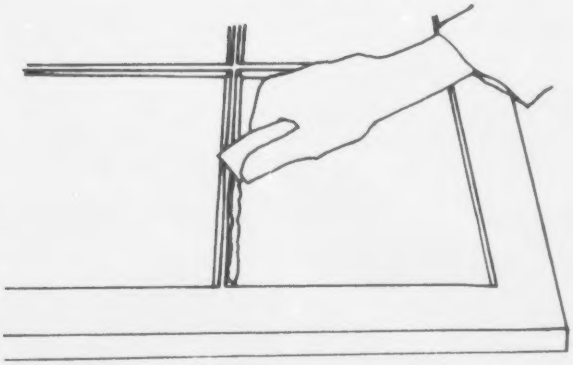
3. Break the glass by grasping it firmly on each side of the cut with the thumb and forefinger, then give a slight outward and downward twist.
Caution: Be sure to wear gloves and safety glasses to reduce the chances of injury.



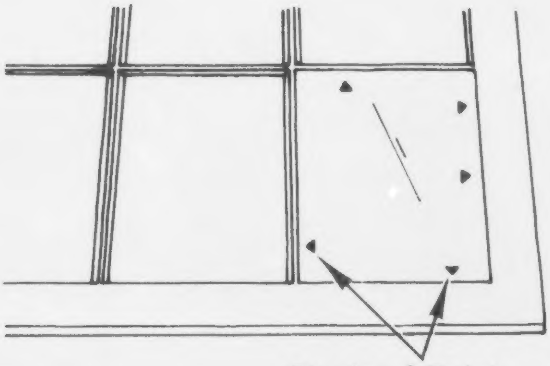
4. Apply a light coat of oil or a primer coat of paint to prevent the wood from absorbing the oil from the glazing compound.



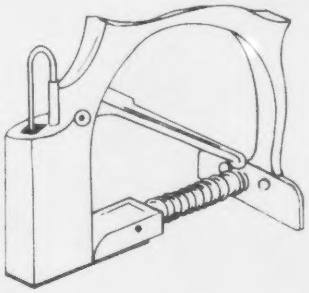
5. Apply a thin layer of glazing compound to the wood frame before inserting the glass to seal and bed the glass in the frame.



6. Place the glass in the frame and fasten with glaziers' points. Use two on a side. Use a point driver, if available, or a small hammer to set the points.

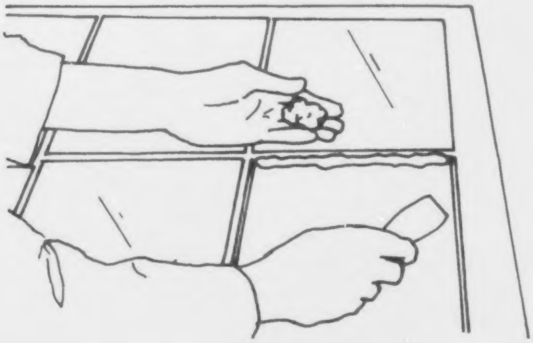


Glaziers' Points



Point Driver

7. Applying glazing compound around the glass with a putty knife. Work the glazing compound in the hands until it is soft. Place a ribbon of compound on the frame next to the glass. Press it into shape with the putty knife. To keep the compound from curling up as you draw the putty knife along the frame hold the knife blade as flat as possible next to the ribbon of compound. The compound should cover the glass to the depth of the wood on the other side of the glass and cover the width of frame. The finish should be smooth and even on all sides.



QUESTIONS:

1. Why should you not buy large quantities of glazing compound?
2. What are some common types of window glass?
3. Where should crystal sheet not be used?
4. What techniques can be used to cut large pieces of glass?

OBERVATIONS:

Briefly outline Illinois' glass safety regulations.

APPLICATIONS:

Identify some home or job situations where this skill can be useful to you.

JOB SHEET 6

PIPE FITTING WITH STEEL PIPE

OBJECTIVES:

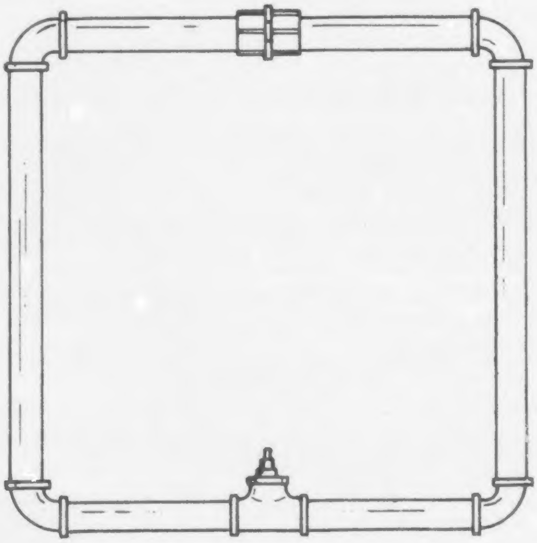
1. To develop the ability to measure cut and ream steel pipe.
2. To develop the ability to identify and properly use pipe fitting tools and equipment.
3. To develop the ability to thread and assemble steel pipe.

MATERIALS:

1. ½" steel pipe (2 piece approximately 24" long and 4 piece 12 inches long)
2. 4-½" 90 degree elbows
3. ½" steel union
4. ½" X ½" X ½" steel tee
5. Pipe joint compound
6. Pipe fitting tools (cutter, pipe tap and die set, and reaming tools)
7. VAS filmstrip 480, Identification of Pipe and Fittings

PROCEDURES:

1. Secure pipe in pipe vise and cut to proper length as suggested by the instructor.
2. Ream and thread the six pieces. Use cutting oil when necessary to avoid damaging the threads and dulling the pipe die.
3. Using pipe joint compound, assemble the pipe using pipe vise wrenches. The tee should be toward the inside.



4. Attach an air compressor hose connector to the tee, then attach the air compressor hose. Submerge the assembled pipe project under water and check for leaks.

QUESTION:

1. What precautions for use are listed on the pipe compound?

2. Why is it necessary to use pipe joint compound. And what types are commonly used?

3. How are pipe threads different from other threads?

4. How do you determine how far to thread the pipe?

OBSERVATIONS:

What safety precautions should you observe in pipe fitting. Briefly outline the technique used in cutting and threading a pipe.

APPLICATIONS:

How can you use these skills at home or with your S.O.E.P.?

JOB SHEET 7

SOLDERING

OBJECTIVES:

1. To develop the ability to identify and understand various types of solder.

2. To develop the ability to properly use and care for soldering equipment.

3. To develop the ability to sweat a fitting on copper tubing.

4. To develop the ability to sweat a lap joint using galvanized or black metal.

MATERIAL:

1. Soldering iron and a propane torch
2. 50-50 solid 1/8" wine solder
3. Soldering past or soldering flux
4. Emery cloth and or No. 00 steel wool 5. 2-3" X 3" pieces of 16 gauge sheet metal (black or galvanized steel)
6. 6" piece of ½" copper tubing
7. ½" copper MIP adapter
8. VAS Unit, Soldering for Home, Farm and Shop Applications

PROCEDURE:

A. Soldering Sheet Metal Lap Joint

1. Straighten the 3" X 3" pieces of sheet metal so there are no gaps between the surfaces when the pieces are lapped together.

2. Clean the metal with steel wool or sand cloth. Remove all oil, dirt, and grease. Do no touch the cleaned surfaces prior to fluxing.

3. Clean the pieces chemically by applying a coating of soldering flux.

4. Assemble the pieces by lapping them about ¼ inch.

5. Lay the hot soldering iron on top of the lap joint. Hold pressure on the metal until the metal is hot enough to melt the solder. Be sure the soldering iron copper tip is well tinned.

6. When the base metal is at the correct soldering temperature the solder will melt and be drawn between the lapped pieces. Do not apply too much solder. The joints should be sealed on both sides of the lap with solder.

7. Allow the joint to cool and harden before it is moved.

8. Remove access solder and flux with a wire brush, steel wool or fine emery c[illegible]

B. Sweating ½" Copper Tubing

1. Cut the tubing to the required length with a tubing cutter or a hacksaw (32 teeth per inch).

2. Ream the tubing with a reamer, round, or half-round file to remove any inside or outside burns. Make certain the tubing is round and fits properly into the fitting.

3. Clean the outside of the tube and the inside of the fitting with steel wool or emery cloth until the surface is bright and free of dirt, grease, and oil. Do not touch the cleaned surface prior to fluxing.

4. Apply a thin complete coating of flux or past to the cleaned portion of the tube and fitting.

5. Assemble the tubing and fitting and revolve the fitting once or twice to spread the flux evenly.

6. Use a propane torch to heat the joint until the wire solder melts when touched to the metal joint. Move the flame away as solder is added to the joint.

7. Continue adding solder and heat alternately until the joint is filled with solder. Move the flame around to prevent over heating in one spot.

8. Avoid applying too much solder to the joint. If using 1/8" wire solder, it will require about ½ inch of solder to complete a ½ inch soldered joint.

9. Do not move the soldered joint until it is hardened.

10. Remove excess solder and flux with a damp cloth or wire brush.

QUESTIONS:

1. The solder alloy is composed of what metals?

2. Why is it necessary to clean joints physically and chemically?

3. What does the flux do?

4. What is "tinning" a soldering iron?

Why should an iron be tinned?

OBSERVATIONS:

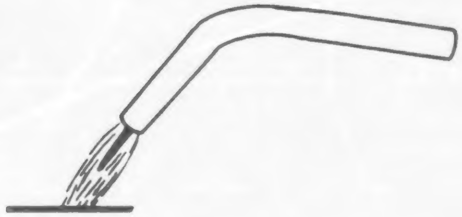
Briefly explain how to solder a tee joint to copper tubing.

APPLICATION:

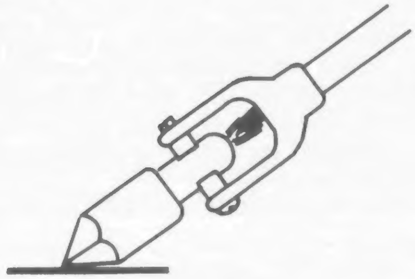
How can these skills be applied to your S.O.E.P. or your home situation.

SOLDERING

1. Open flame

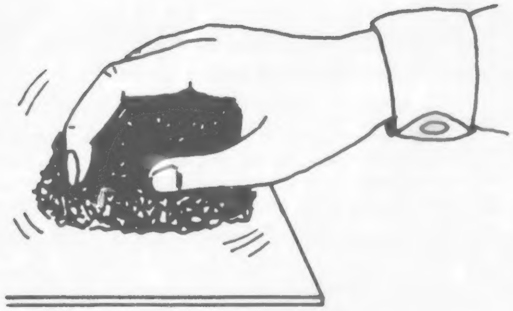


2. Enclosed flame



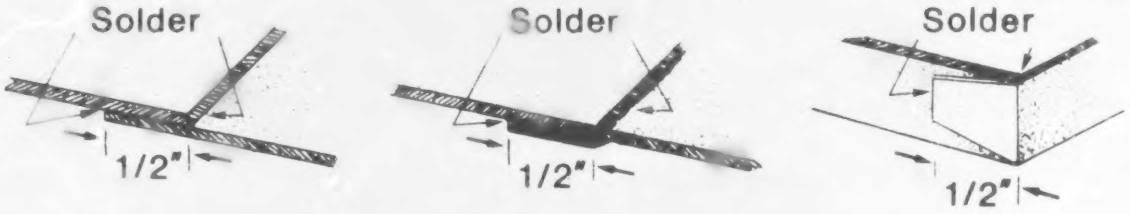
Procedure:

1. Clean metal
2. Add flux
3. Tin joint
4. Add solder
5. Clean soldered joint

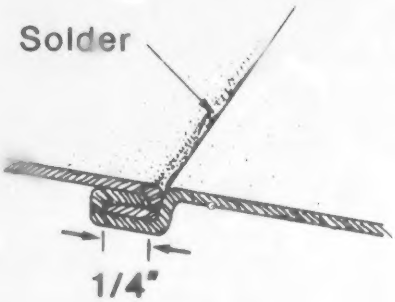


SOLDERING SHEET METAL

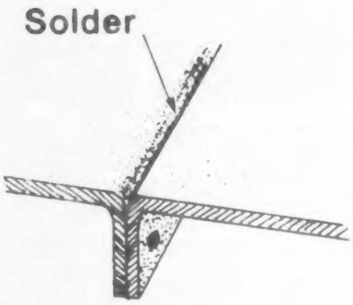
1. Lap Joints


Solder
1/2"
Solder
1/2"
Solder
1/2"

2. Lock Joint

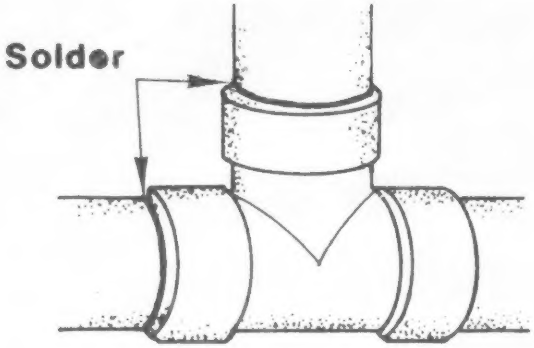


3. Flange Joint

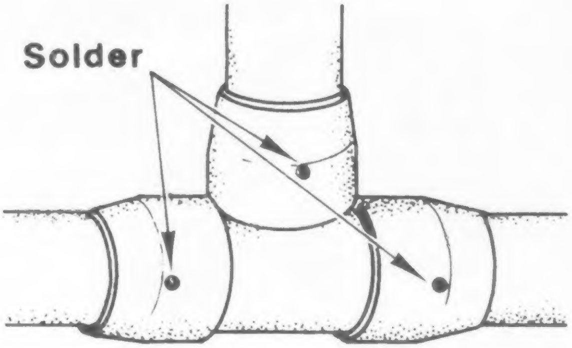


SWEAT-TYPE FITTINGS

Sweat-type fittings are used for joints and connections in copper tubing.



Plain



With holes

1. Prepare tube and fitting

2. Connect tube and fitting

3. Heat evenly

4. Remove heat--add solder

5. Heat--add more solder

6. Clean joint

JOB SHEET 8

FORGING COLD CHISEL

OBJECTIVES:

1. To develop the ability to forage metal.
2. To develop the ability to anneal and temper tool steel.
3. To develop the ability to shape and polish steel.

MATERIALS:

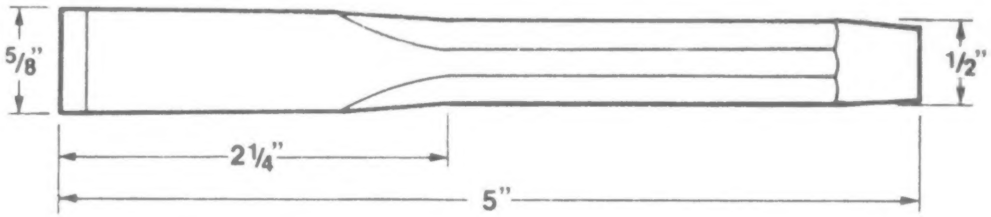
1. Forage or use a large heating tip an acetylene welder.
2. ½ inch round or octagon tool steel (old cold chisel can be used and reshaped)
3. Anvil and hardy
4. Blacksmith hammer and pliers
5. VAS Unit 3042, Hot Metal Work
6. VAS Unit 3041, Ferrous Metals - Properties Identification and Treatment

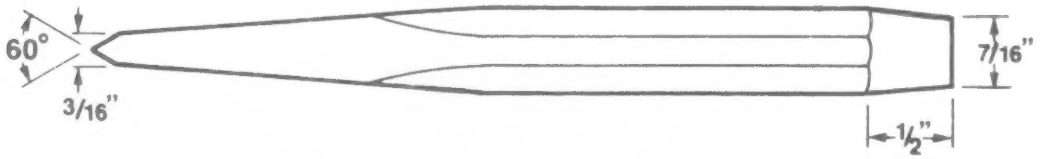
PROCEDURE:

Note: It is suggested that this exercise be practiced on a piece of mild ½" steel rod before using a piece of tool steel.

1. Obtain a piece of steel about 5" long. Then slowly heat two-thirds of the rod to a cherry-red and draw out to a true taper. Hammer alternately on the edge as well as the flat sides.

2. The length of the taper should be about 2½ inches long and the tapered end should be about 5/8" wide and 1/8 inch thick at the end.





3. Use a straight edge to check for evenness of taper.

4. Do not heat the tool steel above the cherry-red color and do not hammer the tool steel when it cools to a black heat because it will crack or split.

5. Anneal the chisel by slowly heating it to a cherry-red and then cover it with lime or sand to slow the cooling.

6. When cool, file or grind the taper until the chisel is bright.

7. Reheat the tapered two-thirds of the chisel evenly until it is an even cherry-red color.

8. Dip about half the heated end into water. Keep moving the chisel around in the water and up and down until water will remain on the cooled end momentarily.

9. Polish the tip with a piece of emery cloth (be careful, the chisel is still very hot).

10. Watch the tempering colors return to the tip. When dark blue or purple reaches the tip, plunge the whole chisel into water and hold it there until cold enough to handle without gloves.

11. Grind the cutting edge to a 60 degree angle.

12. Grind and shape the opposite end to reduce mushrooming. The end should be ground to a diameter of about seven-sixteenths inch and tapered back one-half inch.

13. Polish with emery cloth or steel wool.

QUESTIONS:

1. Why should tool steel not be heated above a cherry-red color?

2. What does annealing do to tool steel?

3. What does tempering do to tool steel?

4. Why do you not temper the entire length of the chisel?

OBSERVATIONS:

Briefly outline the forging technique to use when drawing steel into shape.

APPLICATION:

Identify how these skills can be applied to your S.O.E.P. or home situation.